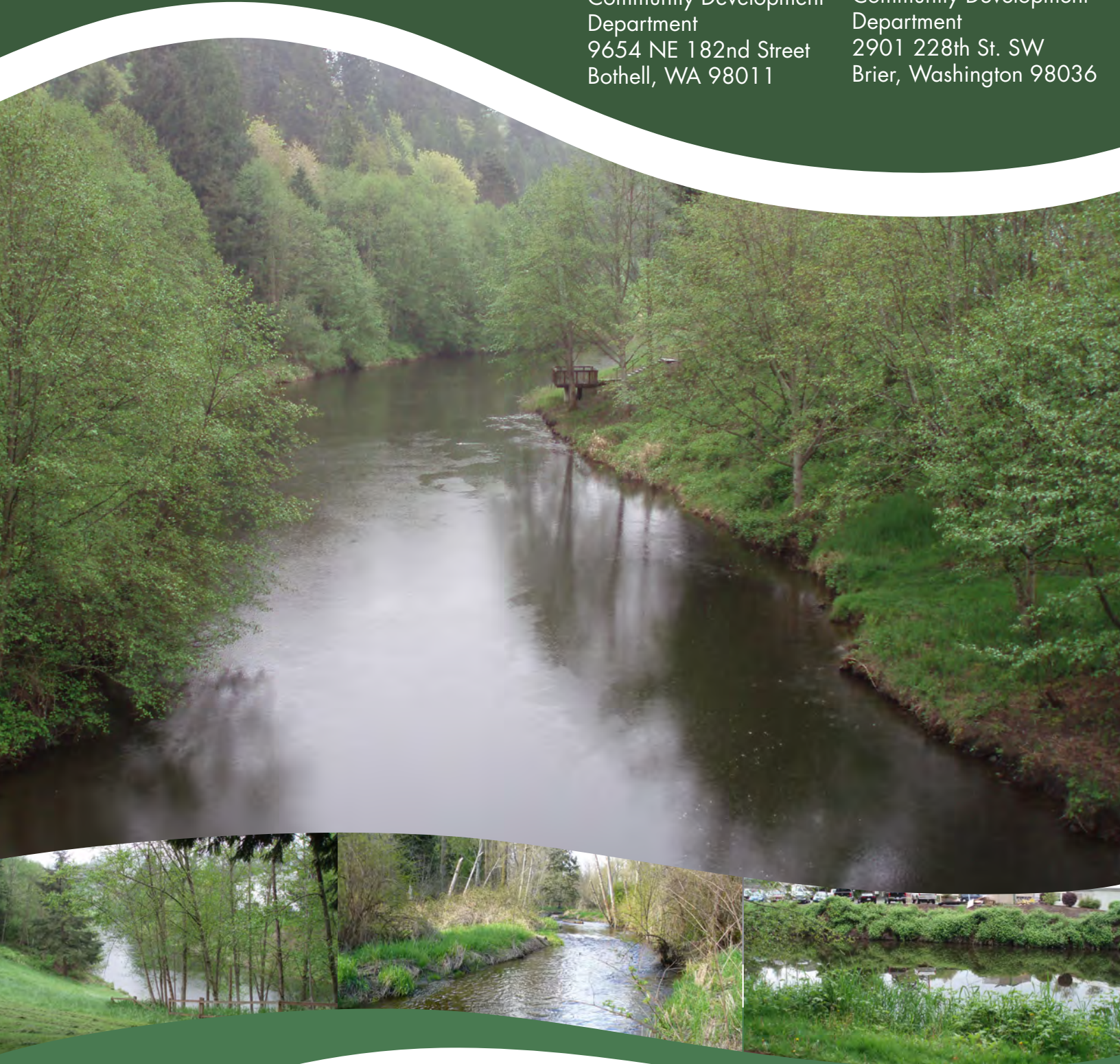


FINAL

Shoreline Analysis Report for the Cities of Bothell and Brier Shorelines: Sammamish River, North Creek, and Swamp Creek

Prepared for: City of Bothell
Community Development
Department
9654 NE 182nd Street
Bothell, WA 98011

City of Brier Planning and
Community Development
Department
2901 228th St. SW
Brier, Washington 98036



FINAL

**CITIES OF BOTHELL & BRIER
GRANT NOS. G1000013 AND G1000037**

SHORELINE ANALYSIS REPORT

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City of Brier Planning and Community
Development Department
2901 228th St. SW
Brier, Washington 98036

Prepared by:



750 Sixth Street South
Kirkland . WA 98033

p 425.822.5242
f 425.827.8136
watershedco.com



710 Second Avenue, Suite 550
Seattle, WA 98104



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**The Watershed Company
Reference Number:
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The Watershed Company Contact Person:

Amy Summe

ICF International Contact Person:

Lisa Grueter



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TABLE OF CONTENTS

	Page #
1 Introduction	1
1.1 Background and Purpose.....	1
1.2 Shoreline Jurisdiction.....	1
1.3 Study Area	4
1.3.1 City of Bothell	4
1.3.2 City of Brier	4
2 Current Regulatory Framework Summary	5
2.1 Cities of Bothell and Brier	5
2.2 State and Federal Regulations	6
3 Elements of the Shoreline Inventory & Specific Conditions ..	8
3.1 Introduction	8
3.2 Assessment Unit Conditions	11
3.3 Data Gaps.....	13
4 Analysis of Ecological Functions and Ecosystem Wide Processes	19
4.1 Geographic and Ecosystem Context (WRIA 8).....	19
4.1.1 North Creek	20
4.1.2 Swamp Creek	24
4.1.3 Sammamish River	26
4.2 Major Land Use Changes and Current Shoreline Condition	28
4.3 Analysis of Ecological Functions and Processes.....	29
4.3.1 North Creek – Thrasher’s Corner (north of SR-524)	32
4.3.2 North Creek – Centennial Park.....	36
4.3.3 North Creek – Canyon Park.....	40
4.3.4 North Creek – Fitzgerald (228 th Street SE to 240 th Street SE)	44
4.3.5 North Creek – North Creek Business Parks (240 th Street SE to I-405).....	48
4.3.6 North Creek - Campus (I-405 to Sammamish River)	53
4.3.7 Swamp Creek – City of Bothell and City of Brier	58
4.3.8 Sammamish River – Reaches 9 through 14.....	63
4.3.9 Sammamish River – Bothell Business Park Floodway	70
4.4 Restoration Opportunities	73

5	Land Use Analysis and Implications	81
5.1	Introduction	81
5.2	Land Use Analysis	82
5.3	Shoreline Designations	85
6	Public Access Analysis and Implications	87
6.1	Introduction	87
6.2	Assessment Unit Conditions	88
6.3	Public Access Needs or Opportunities	90
6.3.1	City of Bothell	90
6.3.2	City of Brier	91
7	Shoreline Management Recommendations	91
7.1	Shoreline Master Program.....	91
7.1.1	Shoreline Environment Designation Provisions	91
7.1.2	General Policies and Regulations	103
7.1.3	Shoreline Modification Provisions	106
7.1.4	Shoreline Uses.....	108
7.2	Restoration Plan.....	110
8	References	112

Appendix A: City of Bothell Assessment of Shoreline Jurisdiction

1. Shoreline Jurisdiction Assessment, December 2009, The Watershed Company
2. Assessment of Upper Extent of North Creek Jurisdiction, January 2011, Washington Department of Ecology

Appendix B: City of Brier Assessment of Shoreline Jurisdiction

Appendix C: City of Bothell Inventory and Analysis Map Folio

Figure 1. Previous Shoreline Management Area	C-1/2
Figure 2. Proposed Shoreline Management Area	C-3/4
Figure 3. Comprehensive Plan Land Use	C-5 to C-8
Figure 4. Zoning	C-9 to C-11
Figure 5. Current Land Use.....	C-12/13
Figure 6. Sanitary Sewer System.....	C-14/15
Figure 7. Surface Water System and Outfalls	C-16/17
Figure 8. Impervious Surfaces	C-18/19
Figure 9. Shoreline Modifications	C-20/21
Figure 10. Public Access.....	C-22/23
Figure 11. Soils	C-24/25
Figure 12. Geology.....	C-26/27
Figure 13. Floodplain and Wetlands.....	C-28/29
Figure 14. Landslide and Seismic Hazard Areas	C-30/31
Figure 15. Priority Habitats & Species & Fish Distribution	C-32/33

Figure 16. Vegetation	C-34/35
Figure 17. 303(d) Listed Waters and Permitted Sites	C-36 to C-39
Figure 18. Restoration Opportunities (Cities of Bothell and Brier)	C-40 to C-42
Figure 19. Reach Map (Cities of Bothell and Brier)	C-43/44
Figure 20. Shoreline Ecological Function	C-45 to C-56
Appendix D: City of Brier Inventory and Analysis Map Folio	
Proposed Shoreline Jurisdiction	D-1
Planned Land Use	D-2
Zoning	D-3
Current Land Use	D-4
Sanitary Sewer System	D-5
Surface and Stormwater System	D-6
Impervious Surface	D-7
Public Access	D-8
Soils	D-9
Surficial Geology	D-10
Floodplains and Wetlands	D-11
Landslide and Seismic Hazard Areas	D-12
Priority Habitats & Species & Fish Distribution	D-13
Shoreline Vegetation	D-14
Permitted Sites and Impaired Waters	D-15

LIST OF EXHIBITS

Exhibit 1.	Map of shoreline study area.	2
Exhibit 2.	Overview of Reach Areas.....	12
Exhibit 3.	Overview of the Cedar Sammamish Water Resource Inventory Area (WRIA) 8.....	19
Exhibit 4.	Aerial photo of North Creek – Thrasher’s Corner assessment unit (Reach 1)	33
Exhibit 5.	Aerial photo of North Creek – Centennial Park assessment unit (Reach 2)	37
Exhibit 6.	Aerial photo of North Creek – Canyon Park assessment unit (Reach 3).....	41
Exhibit 7.	Aerial photo of North Creek – Fitzgerald assessment unit (Reach 4).....	45
Exhibit 8.	Aerial photo of North Creek – North Creek Business Parks assessment unit (Reach 5)	49
Exhibit 9.	Aerial photo of North Creek - Campus assessment unit (Reach 6).....	54
Exhibit 10a.	Aerial photo of North Creek - City of Bothell assessment unit north of 228 th Street SW (Reach 7a).....	58
Exhibit 10b.	Aerial photo of North Creek - City of Bothell assessment unit south of 228 th Street SW (Reach 7b).....	59
Exhibit 11.	Aerial photo of Swamp Creek - City of Brier assessment unit (Reach 8)	60
Exhibit 12.	Aerial photo of Sammamish River – Reach 9 (Woodinville Drive) and Reach 10 (Brackett’s Landing)	64
Exhibit 13.	Aerial photo of Sammamish River – Reach 11 (Sammamish River Park), Reach 12 (Downtown), Reach 13 (Bothell Way Corridor), and Reach 14 (Wayne Golf Course)	65

Exhibit 14.	Aerial photo of Sammamish River – Reach 15 (Bothell Business Park Floodway)	71
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LIST OF TABLES

Table 1.	Shoreline Inventory Elements and Information Sources.	8
Table 2.	Summary of Inventory by North Creek Assessment Units.	15
Table 3.	Summary of Inventory by Swamp Creek Assessment Units.	16
Table 4.	Summary of Inventory by Sammamish River Assessment Units.	17
Table 5.	Minimum water quality standards and impairments by shoreline unit based on Ecology's (electronic source) Washington State Water Quality Assessment.	22
Table 6.	Identification of Functions Evaluated for Each Major Process Based on Ecology's Shoreline Master Program Guidelines (WAC 173-26).	30
Table 7.	Reach ranking order from highest to lowest function based on mean reach scores assigned in Tables 8 through 16.	32
Table 8.	Function Summary of North Creek – Thrasher's Corner (Reach 1).	33
Table 9.	Function Summary of North Creek – Centennial Park (Reach 2).	37
Table 10.	Function Summary of North Creek – Canyon Park (Reach 3).	41
Table 11.	Function Summary of North Creek – Fitzgerald (Reach 4).	46
Table 12.	Function Summary of the North Creek – North Creek Business Parks (Reach 5).	50
Table 13.	Function Summary of North Creek – Campus (Reach 6).	54
Table 14.	Function Summary of Swamp Creek – City of Bothell and City of Brier (Reaches 7 and 8).	60
Table 15.	Function Summary of the Sammamish River – Reaches 9 through 14... ..	66
Table 16.	Function Summary of Sammamish River – Bothell Business Park Floodway (Reach 15)	71
Table 17.	Restoration opportunities by reach (Figures 18A & B, pages C-40 to C-42). SC=Swamp Creek, NC= North Creek, and SR= Sammamish River.	75
Table 18.	Likely changes in land use and implications for shoreline management.	82
Table 19.	Shoreline Designations – Current City of Bothell Designations and Ecology Recommendations.	86
Table 20.	Acreage of City Open Space and Parks by Assessment Unit within Shoreline Jurisdiction.	88
Table 21.	Shoreline Environment Designation Evaluation	93

LIST OF ACRONYMS AND ABBREVIATIONS

CAO	Critical Areas Ordinance
CCC/UW-Bothell	Cascadia Community College/ University of Washington Bothell
Corps.....	U.S. Army Corps of Engineers
Ecology	Washington Department of Ecology
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information System (Mapping system)
GMA	Growth Management Act
HPA.....	Hydraulic Project Approval (Permit for aquatic areas from WDFW)
LIDAR.....	Light Detection and Ranging (optical remote sensing technology that uses laser pulses, similar to radar which uses radio waves)
LWD	Large Woody Debris
NCFWCHPA	North Creek Fish and Wildlife Critical Habitat Protection Area
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
PHS.....	Priority Habitats and Species
PROSAP	Parks and Recreation Open Space Action Plan (City of Bothell)
SEPA.....	State Environmental Policy Act
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SSURGO.....	Soil Survey Geographic
TMDL	Total Maximum Daily Load
TWC	The Watershed Company (Consultant)
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
WAC.....	Washington Administrative Code
WADNR.....	Washington Department of Natural Resources
WDFW.....	Washington Department of Fish and Wildlife
WRIA 8.....	Water Resource Inventory Area 8 (Lake Washington/ Cedar/ Sammamish Watershed)

SHORELINE ANALYSIS REPORT

CITIES OF BOTHELL AND BRIER SHORELINES: SAMMAMISH RIVER, NORTH CREEK, AND SWAMP CREEK

1 INTRODUCTION

1.1 Background and Purpose

The Cities of Bothell and Brier (Cities) obtained grants from the Washington Department of Ecology (Ecology) in 2009 to complete comprehensive updates of their respective Shoreline Master Programs (SMPs). One of the first steps of the update process is to inventory and characterize the Cities shorelines as defined by the state's Shoreline Management Act (SMA) (RCW 90.58) (Exhibit 1). This analysis was conducted in accordance with the Shoreline Master Program Guidelines (Guidelines, Chapter 173-26 WAC) and project Scope of Work promulgated by Ecology, and includes all areas within each City's limits and their urban growth areas. Under these Guidelines, the Cities must identify and assemble the most current, applicable, accurate and complete scientific and technical information available.

This shoreline inventory and analysis will describe existing conditions and characterize ecological functions in the shoreline jurisdiction. This assessment of *current* condition will serve as the baseline against which the impacts of future development actions in shoreline jurisdiction will be measured. The Guidelines require that the Cities demonstrate that their updated SMP yields "no net loss" in shoreline ecological functions relative to the baseline (current condition) due to its implementation. The no net loss requirement is a new standard in the Guidelines that is intended to be used by local jurisdictions to test whether the updated SMP will in fact accomplish the SMA objective of protecting ecological functions.

Collected information included Watershed Resource Inventory Area (WRIA) documents, Snohomish and King County studies, City documents, scientific literature, personal communications, aerial photographs, internet data, and a brief physical inventory of the Cities' shorelines.

1.2 Shoreline Jurisdiction

As defined by the Shoreline Management Act of 1971, shorelines include certain waters of the state plus their associated "shorelands." At a minimum, the waterbodies designated as shorelines of the state are streams whose mean annual flow is 20 cubic feet per second (cfs) or greater, lakes whose area is greater than 20 acres, and all marine waters. Shorelands are defined as:

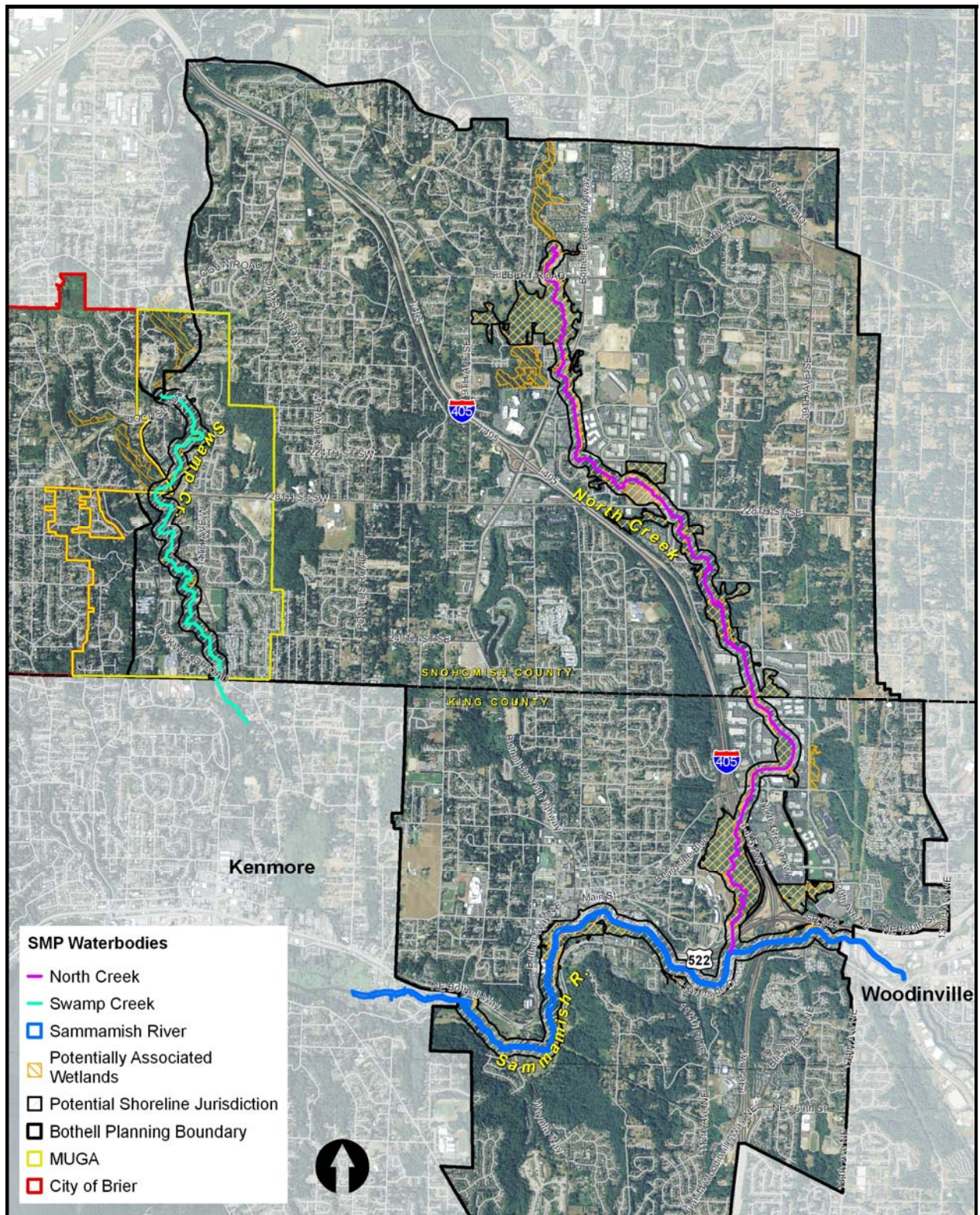


Exhibit 1. Map of shoreline study area.

“those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter...Any county or city may determine that portion of a one-hundred-year-floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom... Any city or county may also include in its master program land necessary for buffers for critical areas (RCW 90.58.030)”

The ordinary high water mark is:

“that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, That in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water” (RCW 90.58.030(2)(b)).

The entirety of the Sammamish River within Bothell city limits is a regulated Shoreline. According to U.S. Geological Survey (USGS) calculations updated in 1998 and utilized by Ecology, North Creek is a regulated Shoreline waterbody to a point just north of Maltby Road / SR – 524. As part of the December 2009 jurisdiction assessment conducted by The Watershed Company, additional associated wetlands extended upstream to a point just south of 196th Street SE, the City’s planning area boundary.

On January 12, 2011, Ecology responded to a City request for additional analysis of the upstream limit of North Creek shoreline jurisdiction. Based on Ecology’s analysis of approximately nine years of gage data, Ecology has determined that North Creek has a mean annual flow of 20 cfs north of the USGS point up to approximately 196th Street SE. Ecology’s full assessment memorandum is included in Appendix A, followed by a map showing shoreline jurisdiction consistent with the January 2011 memo. However, because of the timing of this new information, this report and the map folio contained in Appendix B only reflect the jurisdiction as assessed by USGS in 1998. The complete shoreline jurisdiction map that reflects the latest Ecology assessment will be utilized through the remainder of the SMP update. The reach is similar to other studied reaches, and Ecology and the City of Bothell agree further adjustments to the Shoreline Analysis Report are not necessary.

Swamp Creek was recently identified by the USGS as having a mean annual flow of 20 cfs or greater downstream of a point just west of Locust Way along Cypress Way. That point is located in the City of Brier's Municipal Urban Growth Area (MUGA), then meanders downstream through the City of Bothell's MUGA, and then passes for a short distance through the City of Brier's incorporated area, and finally passes through a longer stretch of Bothell's MUGA before leaving the Cities' planning areas to the south. No other streams or lakes within either City are considered part of shoreline jurisdiction, although there are extensive shoreline-associated wetlands in Bothell and Brier along North and Swamp Creeks. A detailed discussion of the entire jurisdiction assessment and determination process can be reviewed in full in Appendices A (Bothell) and B (Brier) of this report.

1.3 Study Area

The study area for this report includes all land currently within both Cities' proposed shoreline jurisdiction, as well as shoreline jurisdiction land within Bothell's and Brier's MUGA (see Exhibit 1 above). Further, the study area includes relevant discussion of the contributing watershed. The total area subject to the Cities' updated SMPs, not including aquatic area, is approximately 716.6 acres in the City of Bothell and 5.0 acres in the City of Brier. An additional approximately 42 and 39 acres, respectively, of potentially associated wetland may also be part of each City's shoreline jurisdiction.

1.3.1 City of Bothell

The City of Bothell straddles the King and Snohomish County line. Within Snohomish County, the City is currently surrounded on all sides by areas of unincorporated Snohomish County. In King County, the City is currently bordered by Kenmore to the west, Woodinville to the east, Kirkland to the south and areas of unincorporated King County to the south and west. The City intends to expand its boundaries within both counties through the annexation process. Within Snohomish County, a MUGA has been identified that would extend the City limits in all directions. Expansion to the west would result in a shared border with the City of Brier, while expansion to the north and east would simply extend the City farther into areas of unincorporated Snohomish County. Within King County, Potential Annexation Areas (PAAs) have been identified to the south, west, and east of the existing City limits. Annexation within King County will primarily transfer small, isolated pockets of County jurisdiction to the City. The City will continue to share borders with the cities of Kenmore, Kirkland, and Woodinville. The City's annexation to the south will eventually result in additional shared border with Kirkland.

1.3.2 City of Brier

The City of Brier is located entirely within Snohomish County. Brier is surrounded by Mountlake Terrace to the west, Kenmore to the south and unincorporated Snohomish

County to the north and east. Portions of the unincorporated area to the east are identified as a MUGA.

2 Current Regulatory Framework Summary

2.1 Cities of Bothell and Brier

The Shoreline Management Act of 1971 brought about many changes for local jurisdictions. The legislative findings and policy intent of the SMA states:

“There is, therefore, a clear and urgent demand for a planned, rational, and concerted effort, jointly performed by federal, state, and local governments, to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines (RCW 90.58.020).”

While protecting shoreline resources by regulating development, the SMA is also intended to provide balance by encouraging water-dependent or water-oriented uses while also conserving or enhancing shoreline ecological functions and values. SMPs will be based on state guidelines, but should be tailored to the specific conditions and needs of the local community.

The City of Bothell adopted its first Shoreline Master Program in 1975, and has subsequently made several amendments to the document (including in 1986, 1990, 1996 and 1998). The City's Comprehensive Plan (Shorelines Element) contains specific shoreline goals and policies that encourage protection or enhancement of, and access to the City's shorelines. The Comprehensive Plan provides goals and policies which have been used in development of the City's regulations, such as those found in the Municipal Code (including critical areas regulations) and the Shoreline Master Program. The City requires enhancement to mitigate adverse impacts; the City encourages voluntary restoration. The Shoreline Master Program Guidelines require that updated Shoreline Master Programs *plan* for restoration, typically accomplished in the future Shoreline Restoration Plan, and also in the use of incentives in the SMP itself which can foster restoration.

Bothell regulations applicable to critical areas were last thoroughly updated in 2005 and amended in 2009 to be consistent with Growth Management Act requirements for use of “best available science.” In those regulations, Bothell specified general stream buffers of 100 feet for shorelines of the state (150 feet for a portion of North Creek between 240th Street SE and 228th Street SE), and wetland buffers that vary between 50 and 125 feet based on wetland classification and a habitat score. There are a number of shoreline and wetland areas within the City that contain functioning buffers of the required widths.

Smaller functioning buffers are found where developments existed prior to the critical areas regulations or where buffers of different widths were previously established in binding site plans.

The City of Brier currently applies a buffer of 200 feet to Swamp Creek, but is undergoing a revision of its critical areas regulations which may reduce this buffer.

Snohomish County adopted a Shoreline Management Master Program on September 25, 1974 and September 30, 1974. The original program was prepared for unincorporated Snohomish County and the following municipalities: Arlington, Brier, Gold Bar, Granite Falls, Index, Lake Stevens, Monroe, Mountlake Terrace, Sultan, and Woodway. Snohomish County is preparing a new SMP applicable only to unincorporated Snohomish County. The City of Brier has been notified by Ecology that it must adopt its own SMP. However, Brier is coordinating with the City of Bothell since Bothell's MUGA includes Swamp Creek upstream and downstream of the City of Brier's potential shoreline jurisdiction.

Shoreline uses, developments, and activities regulated under the Critical Areas Regulations are also subject to each City's Comprehensive Plan, the Municipal Code, the International Building Code, and various other provisions of City, state and federal laws. Any applicant must comply with all applicable laws prior to commencing any use, development, or activity. The Cities will ensure consistency between the SMP and other City codes, plans and programs by reviewing each for consistency during periodic updates of the City's Comprehensive Plan as required by State statute.

2.2 State and Federal Regulations

State and federal regulations most pertinent to development in the Cities' shorelines include the federal Endangered Species Act, the federal Clean Water Act, the state Shoreline Management Act (SMA), and the State Hydraulic Code. Other relevant federal laws include the National Environmental Policy Act (NEPA), Anadromous Fish Conservation Act, Clean Air Act, and the Migratory Bird Treaty Act. State laws which address shoreline issues include the Growth Management Act (GMA), State Environmental Policy Act (SEPA), Watershed Planning Act, Water Resources Act, Salmon Recovery Act, the Water Quality Protection Act, and tribal agreements and case law.

A variety of agencies (e.g., U.S. Army Corps of Engineers (Corps), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Ecology, Washington Department of Fish and Wildlife (WDFW)) are involved in implementing these regulations, but review by these agencies of shoreline development in most cases would be triggered by in- or over-water work, discharges of fill or pollutants into the water, or substantial land clearing. Depending on the nature of the proposed development, state and federal regulations can play an important role in the design and implementation of a shoreline project, ensuring that impacts to shoreline functions and values are avoided,

minimized, and/or mitigated. With the comprehensive SMP update, the Cities will strive to ensure that the SMP regulations are consistent with other State and Federal requirements and explore ways to streamline the shoreline permitting process. A summary of some of the key regulations and agency responsibilities follows.

Section 404: Section 404 of the federal Clean Water Act provides the Corps, under the oversight of the U.S. Environmental Protection Agency (EPA), with authority to regulate “discharge of dredged or fill material into waters of the United States, including wetlands” (EPA, electronic source). The extent of the Corps’ authority and the definition of fill have been the subject of considerable legal activity. As applicable to the Cities shoreline jurisdiction, however, it generally means that the Corps must review and approve most activities in streams and wetlands. These activities may include wetland fills, stream and wetland restoration, and culvert installation or replacement, among others. Similar to SEPA requirements, the Corps is interested in avoidance, minimization, restoration, and compensation of impacts.

Section 10: Section 10 of the federal Rivers and Harbors Appropriation Act of 1899 provides the U.S. Army Corps of Engineers (Corps) with authority to regulate activities that may affect navigation of “navigable” waters. The Sammamish River is a designated navigable waterbody through the entire City of Bothell. Accordingly, proposals to construct new or modify existing over-water structures (including bridges), to excavate or fill, or to “alter or modify the course, location, condition, or capacity of” navigable waters must be reviewed and approved by the Corps. Of particular interest are Corps preferred design standards for residential overwater structures as expressed until recently in the Corps’ Regional General Permit (RGP) 3. This RGP expired in March 2010 and the Corps is currently working on a new body of standards for Lake Washington and Lake Sammamish as a Programmatic Consultation, which will enable those projects complying with the standards to undergo streamlined Corps permitting, particularly with respect to Endangered Species Act consultations (see below). Sammamish River projects will not be covered under the Programmatic Consultation, but could still receive permits after processing by the Corps and ESA consultation.

Federal Endangered Species Act (ESA): Section 9 of the ESA prohibits “take” of listed species. See Section 4.1.1-4.1.3 for identification of federally listed fish species in each waterbody. Take has been defined in Section 3 as: “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” The take prohibitions of the ESA apply to everyone, so any action that results in a take of listed fish or wildlife would be a violation of the ESA and is strictly prohibited. Per Section 7 of the ESA, activities with potential to affect federally listed or proposed species and that either require federal approval, receive federal funding, or occur on federal land must be reviewed by the National Marine Fisheries Service (NOAA Fisheries) and/or U.S. Fish and Wildlife Service (USFWS) via a process called “consultation.”

Section 401 Water Quality Certification: Section 401 of the federal Clean Water Act allows states to review, condition, and approve or deny certain federal permitted actions that result in discharges to state waters, including wetlands. In Washington, Ecology is the state agency responsible for conducting that review, with their primary review criteria of ensuring that state water quality standards are met. Actions within streams or wetlands within the shoreline zone that require a Section 404 permit (see above) will also need to be reviewed by Ecology.

Hydraulic Code: Chapter 77.55 RCW (the Hydraulic Code) gives the Washington Department of Fish and Wildlife (WDFW) the authority to review, condition, and approve or deny “any construction activity that will use, divert, obstruct, or change the bed or flow of state waters.” As applicable to the Cities’ shoreline jurisdiction, however, it generally means that WDFW must review and approve most activities in all three shoreline waterbodies. These activities may include bank stabilization, stream alteration, and culvert installation or replacement, among others. WDFW can condition projects to restore habitats and/or avoid, minimize, and compensate for adverse impacts.

3 Elements of the Shoreline Inventory & Specific Conditions

3.1 Introduction

Development of a shoreline inventory is intended to record the existing or baseline conditions upon which the development of shoreline master program provisions will be examined to ensure the adopted regulations provide no net loss of shoreline ecological functions. At a minimum, local jurisdictions shall gather the inventory elements listed in the Guidelines, to the extent information is relevant and readily available. Table 1 lists those relevant inventory elements for which data is available for the Cities’ shorelines. The table also describes the information collected for each of the required inventory elements. Figures are provided in Appendices C (Bothell) and D (Brier) and depict the various inventory pieces listed in the table, as well as additional analysis. Areas of data gaps are listed in Section 3.3.

Table 1. Shoreline Inventory Elements and Information Sources.

Inventory Element	Information Gathered	City of Bothell Data Sources	City of Brier Data Sources	Map Location (Appendices C and D)
Land Use Patterns	Current land use, zoning, and future land use (comprehensive plan)	City of Bothell GIS, Snohomish County GIS, and King County GIS Revised to	Created by The Watershed Co (TWC) referencing hard-copy maps included in the Comprehensive	Bothell: Figures 3-5, Pages C-5 - C-13 Brier: Pages D-2 - D-4

Inventory Element	Information Gathered	City of Bothell Data Sources	City of Brier Data Sources	Map Location (Appendices C and D)
		incorporate some staff and public knowledge. 2009 data considered current as of 12/2010.	Plan and/or from other information provided the City Considered current as of 12/2010.	
Wastewater facilities	Lines, manholes and other point facilities	City of Bothell 2009 data considered current as of 12/2010.	Converted by TWC from City of Brier CAD Considered current as of 12/2010.	Bothell: Figure 6, Pages C-14 - C-15 Brier: Page D-5
Surface/ Stormwater facilities	Streams, stormwater facilities and pipes	City of Bothell Considered current as of 12/2010.	Converted by TWC from City of Brier CAD Considered current as of 12/2010.	Bothell: Figure 7, Pages C-16 - C-17 Brier: Page D-6
Impervious Surfaces	General impervious surface	USGS (from 2001 aerial photo interpretation at 30-m resolution, source reports 86% accuracy)		Bothell: Figure 8, Pages C-18 - C-19 Brier: Page D-7
Shoreline Modifications	<ul style="list-style-type: none"> Docks and other overwater structures Levees/berms/ other flood barriers 	<ul style="list-style-type: none"> WA Department of Natural Resources (WA DNR), 2002-2006 Generated by TWC from LIDAR and aerial photo analysis, also figure in GeoEngineers 2008 report. <p>Also revised to incorporate staff knowledge.</p>	None mapped by WA DNR, Ecology, or other sources	Bothell: Figure 9, Pages C-20 – C-21 Brier: NA

Inventory Element	Information Gathered	City of Bothell Data Sources	City of Brier Data Sources	Map Location (Appendices C and D)
Public Access Areas	Parks, trails and open spaces	City of Bothell Revised to incorporate some staff and public knowledge. Considered current as of 12/2010.	Created by TWC referencing hard-copy maps included in the Comprehensive Plan and/or from other information provided the City Considered current as of 12/2010.	Bothell: Figure 10, Pages C-22 – C-23 Brier: Page D-8
Soils	Soil types	USDA NRCS (SSURGO), 2009		Bothell: Figure 11, Pages C-24 – C-25 Brier: Page D-9
Surficial Geology	Geologic classifications	WA Division of Geology and Earth Resources, 2000		Bothell: Figure 12, Pages C-26 – C-27 Brier: Page D-10
Floodplains	Floodplains, floodways	Federal Emergency Management Agency (FEMA), November 1999 plus CCC/UW-Bothell map revision provided by UW-Facilities 12/2010.		Bothell: Figure 13, Pages C-28 – C-29 Brier: Page D-11
Wetlands	Potential wetlands	City of Bothell, Snohomish County, King County 2009 data generally plus CCC/UW-Bothell map revision provided by UW-Facilities 12/2010.	City of Brier, Snohomish County GIS 2009 data. Considered current as of 12/2010.	Bothell: Figure 13, Pages C-28 – C-29 Brier: Page D-11
Geologically hazardous areas	Liquefaction, seismic and landslide hazard areas	City of Bothell 2009 data. Considered current as of 12/2010.	Snohomish County GIS 2009 data. Considered current as of 12/2010.	Bothell: Figure 14, Pages C-30 – C-31 Brier: Page D-12
WDFW Priority Habitats & Species	Priority fish, priority wildlife, priority habitats	WA Department of Fish and Wildlife September 2009		Bothell: Figure 15, Pages C-32 – C-33 Brier: Page D-12

Inventory Element	Information Gathered	City of Bothell Data Sources	City of Brier Data Sources	Map Location (Appendices C and D)
Vegetation	Terrestrial vegetation type and land cover	USGS ReGAP, national dataset based on 2001 aerial		Bothell: Figure 16, Pages C-34 – C-35 Brier: Page D-12
Water quality impairment	303(d) waters and regulated sites	Ecology, 2009. Considered current as of 12/2010.		Bothell: Figure 17, Pages C-36 – C-39 Brier: Page D-12
Restoration opportunities	Site-specific and general projects	Various		Bothell: Figure 18, Pages C-40 – C-42 Brier: same as Bothell

3.2 Assessment Unit Conditions

In order to break down the shoreline into manageable units and to help evaluate differences between discrete shoreline areas, the Cities shorelines have been divided into assessment units based on biological character, dominant land use, and location within City limits or the MUGA/PAA as follows and as illustrated on Exhibit 2 below and in Figures 19A and B in Appendix C (pages C-40 to C-42).

1. North Creek – Thrasher’s Corner (north of SR-524)
2. North Creek – Centennial Park
3. North Creek – Canyon Park
4. North Creek – Fitzgerald (228th Street SE to 240th Street SE)
5. North Creek – North Creek Business Parks (240th Street SE to I-405)
6. North Creek – Campus (I-405 to Sammamish River)
7. Swamp Creek – City of Bothell (7a, north of 228th and 7b, south of 228th)
8. Swamp Creek – City of Brier
9. Sammamish River – Woodinville Drive (from east city limits to mobile home park)
10. Sammamish River – Brackett’s Landing (from Valley View mobile home park to Sammamish River Trail bridge crossing)
11. Sammamish River – Sammamish River Park
12. Sammamish River – Downtown (from SRT bridge to Park at Bothell Landing bridge - north bank only)
13. Sammamish River – Bothell Way Corridor (from Bothell Landing Bridge to 96th Avenue NE - north bank only)
14. Sammamish River – Wayne Golf Course (both banks west of 96th Avenue NE)
15. Sammamish River – Bothell Business Park Floodway

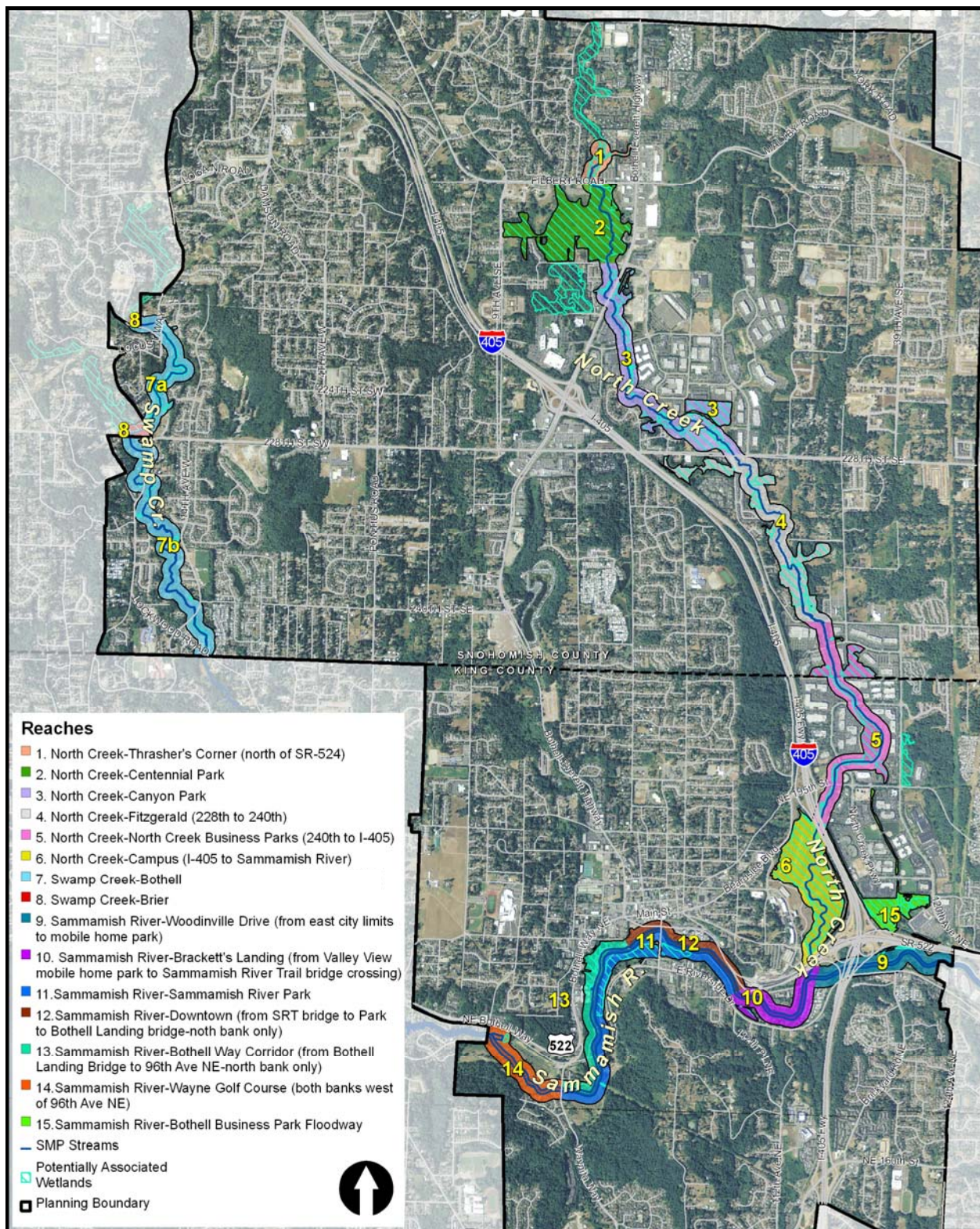


Exhibit 2. Overview of Reach Areas.

Tables 2, 3 and 4 expand upon the relevant above required inventory elements, providing specific detail and data for each of the assessment units. Data in Table 1 considers only information available within the boundaries of each assessment unit. However, in the function summaries found in Tables 7 through 15, references to conditions or influences outside of shoreline jurisdiction may be made when particularly relevant to performance of any function within shoreline jurisdiction.

3.3 Data Gaps

Geographic Information System (GIS) or other detailed information was not located or was incomplete for the following parameters:

- Although the inventory maps show “berms” along the Sammamish River and some of the private levees along North Creek, these illustrations may not be complete or accurate. As noted above, they were developed using Light Detection and Ranging (LIDAR) and orthophotos, with some additional identification by City staff on hard copy maps then converted to GIS. Historic documents issued by the Corps indicate that levees were not constructed along the Sammamish River as part of the 1962-1964 Corps dredging operation. Instead, dredged material was side cast and armoring (rip-rap) was installed, thereby creating a transect 1 to 1 slope side bank that has a similar appearance to levees.
- No studies or mapping sources were found for channel migration. Four areas of potential were identified based on some familiarity with North Creek, discussions with City and DOE staff, and locations of known development, levees, or other modifications: 1) in North Creek - Centennial Park (Reach 2) , 2) the open space/wetland area just north of 228th in North Creek – Canyon Park assessment unit (lower Reach 3), 3) south of 228th Street SE and north of 240th Street SE along the North Creek – Fitzgerald assessment unit (Reach 4), and 4) west of Interstate-405 and north of the North Creek confluence with the Sammamish River within the North Creek – Campus assessment unit (Reach 6).
- FEMA continues to revise floodplain and floodway maps. A preliminary draft is expected to be issued in mid-July 2010, but is not expected to be adopted for a year and should likely not be utilized until it is final. Along North Creek in particular, revised floodplain/floodway mapping could have a significant effect on the jurisdiction boundaries.

The City of Bothell is conducting water temperature monitoring along a stretch of the Sammamish River near Blyth Park. Monitoring is expected to be completed in 2011 and results would be available to influence SMP development where appropriate.

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Table 2. Summary of Inventory by North Creek Assessment Units.

North Creek Assessment Units	Inventory Elements					
	Land Use Patterns	Impervious Surfaces	Vegetation	Floodplain and Floodway	Public Access (Park & Open Space)	Critical Areas (% of assessment unit)
Thrasher's Corner (north of SR-524) Reach 1 (12.80 acres)	<p>Future County: Urban Low Density Residential (4-6 du/ac) (8.9 acres) with a small amount of Urban Center (1 acre) and Urban Commercial (2.2 acres).</p> <p>Future Bothell: Residential (1 du/5,400 square feet), Office-Professional, Community Business, and Motor Vehicle Sales. Combined, Bothell's designations cover less than 1 acre of the reach. (this is currently outside of Bothell city limits)</p> <p>Current Land Uses: mobile homes, single-family residential, office, industrial, and multifamily residential. There is minimal vacant land along the potentially associated wetland.</p>	20.1%	<p>Developed – 45% Forest – 47% Pasture – 2% Other – 6%</p> <p>(+ additional 17.88 acres of potentially associated wetlands upstream of 20 cfs limit)</p>	NA	None.	<p>Wetlands: 32%, 38% priority, and 17.88 additional acres of potentially associated wetlands</p> <p>Geologically Hazardous Areas: Liquefaction 100%, erosive soils/liquefaction also present in the potentially associated wetlands</p>
Centennial Park Reach 2 (77.11 acres)	<p>Future Bothell: A mixture of medium-to high-density residential (1 du/5,400 square feet), Residential Activity Center (This is a high density residential designation – no density limit), and Office-Professional/Community Business/Motor Vehicle Sales Overlay.</p> <p>Current Land Uses: Vacant, (open space associated with Centennial Park) parks and recreation, and commercial, with limited single family residential.</p>	4.9%	<p>Developed – 2% Forest – 78% Pasture – 1% Wetland – 13% Other – 4%</p> <p>(+ additional 19.79 acres of potentially associated wetlands not contiguous with other known shoreline associated wetlands)</p>	Floodway: 14%	<p>31.5 acres open space 4.5 acres of parks</p> <p>Facilities: Centennial Park, including onsite trails.</p>	<p>Wetlands: 96%, 72% priority, and 19.79 additional acres of potentially associated wetlands</p> <p>Geologically Hazardous Areas: Liquefaction 100%, including potentially associated wetlands</p>
Canyon Park Reach 3 (87.45 acres)	<p>Future Bothell: Plan designates the majority of this reach as Office-Professional/Light Industrial (53.2 acres). The remaining area (34.3 acres) is divided among Office-Professional/Community Business/Light Industrial, low and medium density residential designations, and Residential Activity Centers.</p> <p>Current Land Uses; Parks/recreation and offices with some multifamily and single-family residential, warehouse/industrial, and vacant</p>	21.5%	<p>Developed – 32% Forest – 43% Pasture – 13% Wetland – 12%</p>	Floodway: 15%	Does not contain any public parks or open space, but the area does include private open space, as well as extensive trails along both sides of North Creek that connect the riparian areas with Canyon Park	<p>Wetlands: 43%, 27% priority</p> <p>Geologically Hazardous Areas: Liquefaction 100%, Erosive soils 1%</p>

North Creek Assessment Units	Inventory Elements					
	Land Use Patterns	Impervious Surfaces	Vegetation	Floodplain and Floodway	Public Access (Park & Open Space)	Critical Areas (% of assessment unit)
	land.					
Fitzgerald Reach (228th Street SE to 240th Street SE) Reach 4 (72.05 acres)	Future Bothell: A mix of low and medium-density residential. The majority of the reach also falls within the City's Low Impact Development and North Creek Fish & Wildlife Critical Habitat Protection Area overlays. Current Land Uses: Primarily single-family residences and vacant land.	6.3%	Developed – 18% Forest – 66% Pasture – 7% Wetland – 2% Other – 7%	Floodway: 9%	3.5 acres of private open space, as well as trails connecting residential areas to and along the creek.	Wetlands: 46%, 31% priority Geologically Hazardous Areas: Liquefaction 95%, Erosive soils 15%
North Creek Business Parks (240th Street SE to I-405) Reach 5 (77.25 acres)	Future Bothell: Residential Activity Center/Office-Professional/Community Business/ Light Industrial. Current Land Uses: a mix of commercial, office, parks/recreation, residential, warehouse/industrial, and vacant.	19.2%	Developed – 29% Forest – 32% Pasture – 9% Wetland –29% Other – 2% (+ additional 4.34 acres of potentially associated wetlands not contiguous with other known shoreline associated wetlands)	Floodplain: 29% Floodway: 34% Note: 6,447 linear feet of levee	23.2 acres of private open space and a network of trails connecting the shoreline with the North Creek sports fields farther south and the North Creek Regional Trail to the north.	Wetlands: 47%, 43% priority, and 4.34 additional acres of potentially associated wetlands Geologically Hazardous Areas: Liquefaction 100%, erosive soils/liquefaction also present in the potentially associated wetlands
Campus Reach (I-405 to Sammamish River) Reach 6 (70.40 acres)	The Bothell Comprehensive Plan designates the area as Campus which matches the current uses by the Cascadia Community College and University of Washington-Bothell.	24.0%	Developed – 17% Forest – 35% Pasture – 25% Wetland – 8%	Floodplain: 81% Floodway: 30%	Trails provide access to the perimeter of the open space/wetland area. Visual access is available from the campus and from the adjacent I-405 and SR-522 freeways.	Wetlands: 84%, 42% priority Geologically Hazardous Areas: Liquefaction 99%, Erosive soils 4%

Table 3. Summary of Inventory by Swamp Creek Assessment Units.

Swamp Creek Assessment Units	Inventory Elements					
	Land Use Patterns	Impervious Surfaces	Vegetation	Floodplain and Floodway	Public Access (Park & Open Space)	Critical Areas (% of assessment unit)
City of Bothell Reach 7a, b (109.22 acres)	Future County: Designated for Urban Low Density Residential use (4-6 du/ac). Current Land Uses: single-family residences and parks and open space.	11.6%	Developed – 24% Forest – 74% Other – 2%	Floodway: 14%	5.6 acres of parks on Locust Way. Also 22 acres of private open space.	Wetlands: 10%, 0.1% priority Geologically Hazardous Areas: Liquefaction 78%, Erosive soils 9% Fish & Wildlife Habitat Areas: 24% priority riparian zones

Swamp Creek Assessment Units	Inventory Elements					
	Land Use Patterns	Impervious Surfaces	Vegetation	Floodplain and Floodway	Public Access (Park & Open Space)	Critical Areas (% of assessment unit)
City of Brier Reach 8 (5.01 acres)	Future County: Urban Low Density Residential (4-6 du/ac). Future Brier: Low-density, large-lot residential development. Current Land Uses: Single-family residences and vacant land.	8.9%	Developed – 32% Forest – 67% (+ additional 39.01 acres of unconfirmed potentially associated wetlands)	Floodway: 14%	None.	Wetlands: 2%, 47% priority Fish & Wildlife Habitat Areas: 47% urban natural open space, 2% priority riparian zones

Table 4. Summary of Inventory by Sammamish River Assessment Units.

Sammamish River Assessment Unit	Inventory Elements					
	Land Use Patterns	Impervious Surfaces	Vegetation	Floodplain and Floodway	Public Access (Park & Open Space)	Critical Areas (% of assessment unit)
Woodinville Drive Reach (from east city limits to mobile home park) Reach 9 (33.71 acres)	Future Bothell: Designates roughly half of this reach as Park, with the remainder designated for Office-Professional, Community Business, Light Industrial, General Commercial, Mobile Home Park, or Residential (1 du/4,000 square feet). Current Land Uses: parks and open space, with a mix of commercial, office, transportation facilities, and vacant land.	30.9%	Developed – 40% Forest – 32% Wetland –28%	Floodplain: 41% Floodway: 26%	14 acres of public open space and a segment of the Sammamish River Trail.	Wetlands: 3% Geologically Hazardous Areas: Liquefaction 84%, Erosive soils 4%
Brackett’s Landing Reach (from Valley View mobile home park to Sammamish River Trail bridge crossing) Reach 10 (28.94 acres)	Future Bothell: Designated primarily for residential development at a variety of densities Current Land Uses: Single-family homes, multifamily residences, and mobile homes. A small amount of land is currently vacant (less than 3 acres).	34.7%	Developed – 71% Forest – 11% Pasture – 2% Wetland –17%	Floodplain: 16% Floodway: 16%	2.5 acres of public open space and 0.3 acres of Brackett’s Landing Park. A segment of the Sammamish River Trail also traverses the area.	Wetlands: 6% Geologically Hazardous Areas: Liquefaction 95%
Sammamish River Park Reach 11 (43.67 acres)	Future Bothell: Primarily designated for Public Parks and Open Space (70%), with the remainder designated for medium density residential uses. Current Land Use: Vacant land, followed by parks and recreation uses and single-family residences.	9.8%	Developed – 17% Developed Open Space – 7% Forest – 70% Pasture – 1% Wetland –4%	NA	33.7 acres of open space 1.5 acres of parks Facilities: Sammamish River Park and the Sammamish River Trail	Wetlands: 20% priority Geologically Hazardous Areas: Liquefaction 100%, Erosive soils 6% Fish & Wildlife Habitat Areas: 3% 400’ eagle buffer and 16% 800’ eagle buffer
Downtown (from SRT bridge to Park at Bothell Landing bridge - north bank only) Reach 12	Future Bothell: Designated primarily as SR-522 Corridor, Mobile Home Park, or Public Park and Open Space. A small area of Downtown Neighborhood (less than 2 acres) also falls within the reach boundaries.	54.8%	Developed – 80% Forest – 12% Wetland –8%	Floodplain: 8% Floodway: 3%	0.6 acres of open space 1.7 acres of parks Facilities: The Park at Bothell Landing, and public open space. Pedestrian trails	Geologically Hazardous Areas: Liquefaction 85%, Erosive soils 50%

Sammamish River Assessment Unit	Inventory Elements					
	Land Use Patterns	Impervious Surfaces	Vegetation	Floodplain and Floodway	Public Access (Park & Open Space)	Critical Areas (% of assessment unit)
(17.31 acres)	Current Land Uses: Mostly mobile homes and vacant land.				provide access to the Sammamish River between Downtown Bothell and Bothell Landing.	
Bothell Way Corridor (from Bothell Landing Bridge to 96th Avenue NE - north bank only) Reach 13 (25.22 acres)	Future Bothell: Plan designates approximately half of this reach as Public Park and Open Space, with the remainder divided between SR-522 Corridor and Residential (1 du/4,000 square feet) designations. Current Land Uses: Vacant and multi-family residential.	25.9%	Developed – 42% Developed Open Space – 1% Forest – 55% Pasture – 1% Wetland –1%	Floodplain: 20% Floodway: 15%	5.5 acres of open space 7.4 acres of parks Facilities: Portions of the Park at Bothell Landing, as well as several acres of public open space. Pedestrian trails provide access between Downtown Bothell and Bothell Landing.	Wetlands: 23% Geologically Hazardous Areas: Liquefaction 76%, Erosive soils 24% Fish & Wildlife Habitat Areas: 13% 400’ eagle buffer and 28% 800’ eagle buffer
Wayne Golf Course (both banks west of 96th Avenue NE) Reach 14 (25.70 acres)	Future Bothell: Medium-density residential designations. Current Land Uses: Wayne Golf Course, single-family residences, transportation/utility facilities, and vacant land.	17.0%	Developed – 47% Developed Open Space – 43% Forest – 9%	Floodplain: 11% Floodway: 11%	1.9 acres of public open space In addition, Wayne Golf Course – private open space development rights including a sight easement along the “front nine”	Wetlands: 2% Geologically Hazardous Areas: Liquefaction 86%, Erosive soils 17% Fish & Wildlife Habitat Areas: 2% 400’ eagle buffer and 17% 800’ eagle buffer
Bothell Business Park Floodway Reach 15 (22.88 acres)	Future Bothell: A mixture of Residential-Activity Center, Office-Professional, Community Business, Light Industrial, and Motor Vehicle Sales Overlay. Current Land Uses: Commercial and industrial development, with a very small amount of park land and open space.	14.2%	Developed – 20% Forest – 24% Pasture – 4% Wetland –52% Other – 2%	Floodplain: 50%	0.6 acres of public park 8 acres of privately-owned open space associated with the business park. A trail is also present, linking the business park to the nearby North Creek sports fields.	Wetlands: 76% Geologically Hazardous Areas: Liquefaction 100%

4 Analysis of Ecological Functions and Ecosystem Wide Processes

4.1 Geographic and Ecosystem Context (WRIA 8)

The City of Bothell is located in King and Snohomish County, and the City of Brier is located entirely in Snohomish County. The Cities contain freshwater shorelines associated with Washington State's Water Resource Inventory Area (WRIA) 8 – Cedar/Sammamish (Exhibit 3). WRIA 8 encompasses 692 square miles and collects water from two major rivers (Cedar and Sammamish Rivers) before flowing through Lake Union and ultimately into Puget Sound via the Lake Washington Ship Canal and Hiram M. Chittenden locks.

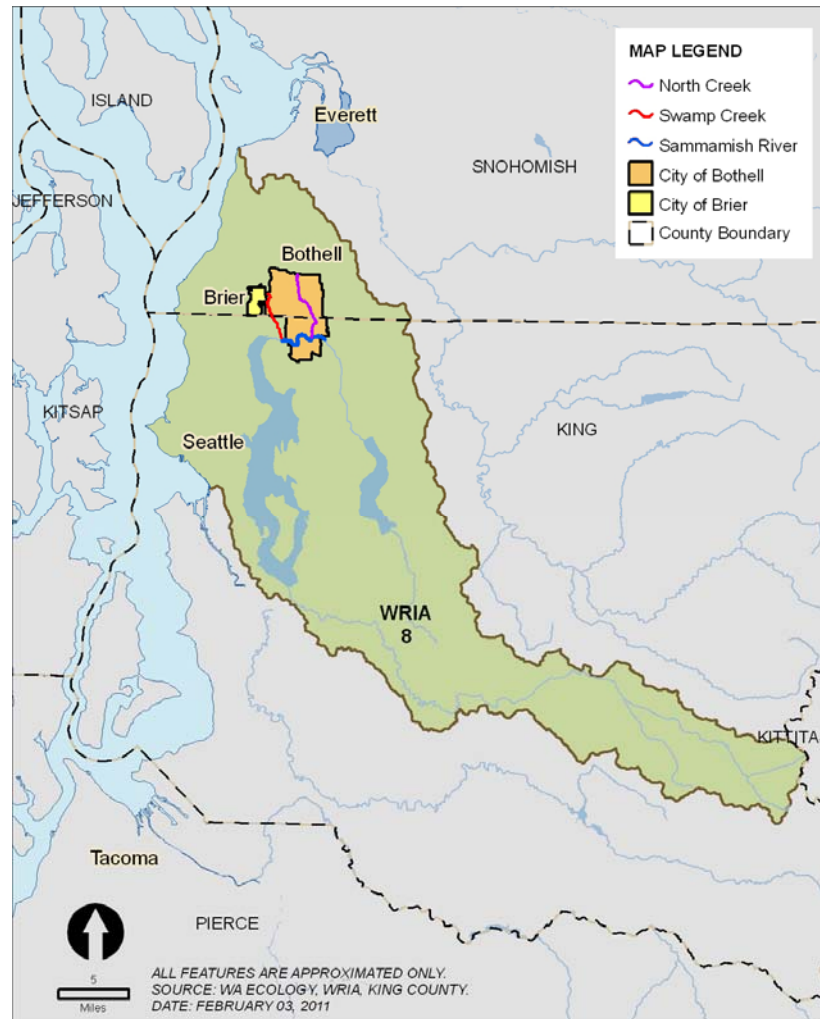


Exhibit 3. Overview of the Cedar Sammamish Water Resource Inventory Area (WRIA) 8.

4.1.1 North Creek

North Creek (WRIA 08.0070) has its headwaters in highly-urbanized south Everett, near Everett Mall, and flows southward, through unincorporated Snohomish County, Mill Creek, and Bothell, where it discharges into the Sammamish River just downstream of River Mile (RM) 4.5. The basin drains a watershed area of approximately 28.5 square miles, roughly two-thirds of which lies in unincorporated Snohomish County (Snohomish County 2002a).

The creek is approximately 13 miles long and begins on a plateau area at approximately 500 feet elevation to descend through a valley that gradually broadens into a recently restored floodplain on the Sammamish River valley floor in the vicinity of the Cascadia Community College/University of Washington Bothell (CCC/UW-B) campus. Basin topography was shaped during the most recent period of glaciation, which left behind an undulating landscape of till, advance and recessional outwash, and lacustrine sediments. Most soils in the watershed are generally a gravelly sandy type loam (Alderwood, Everett, and Norma soils) (Figures 11A & B, pages C-24 & C-25).

Fish Use

North Creek supports runs of federally threatened Chinook salmon (*O. tshawytscha*) and steelhead trout (*O. mykiss*), as well as coho salmon (*O. kisutch*), a federal species of concern, and sockeye (*O. nerka*), kokanee (*O. nerka*); and coastal cutthroat trout (*O. clarki*) (Kerwin 2001), all of which are Washington State Priority Species (Figures 15A & B, pages C-32 & C-33).

Channel/Floodplain/Riparian Condition

Throughout the basin, including through Bothell, channel complexity and connectivity with the floodplain and adjacent stream reaches have been reduced due to road crossings/culverts, streambank hydromodification, channel incision and instability, and historical and on-going clearing and development in riparian areas. Changes in land-use practices have limited in-stream large woody debris (LWD) recruitment that would have contributed to stream channel complexity. Degraded riparian conditions in these reaches, and the lack of LWD recruitment potential have contributed to an overall reduction in habitat function. Current land use practices will generally preclude any long-term LWD recruitment (Kerwin 2001).

Clearing and development in the riparian corridors has reduced the extent of riparian forests and changed land cover from predominantly mature coniferous and mixed forests to a young deciduous forest, and, in turn, from forest to impervious surface land cover. These changes in riparian conditions have led to a reduced amount of available wood that could function as LWD. Basin hydrology has also been significantly altered as a consequence of land use

changes associated with urbanization. The present 2-year flood discharge exceeds the historical 100-year discharge, and 100-year flows have increased by 50 percent (Kerwin 2001). This resulted in a suite of flooding problems along the lower creek in Bothell. Levees constructed by private business park developments in the early 1980s have been raised in height and otherwise modified in recent years to contain the increasing flood flows. The first record of levee installation on North Creek, however, was noted as occurring in 1964 and was completed by the Corps as part of a large-scale flood control project on the Sammamish River (Tetra Tech, Inc. 2002).

Furthermore, the potential for the recruitment of LWD to the stream channel from those areas which are now occupied by levees is virtually eliminated, since Corps and FEMA requirements call for maintaining the levees and associated stream banks in an open and essentially vegetation-free condition. Only grasses and emergents are allowed. This mandated tree-free condition in turn affects the evaluation and analysis of ecological functions (as reported in Table 12, Section 4.3.5).

Water Quality

High measured temperatures in North Creek not only exceed State designated standards, but also are in excess of required temperatures for successful salmonid rearing. These high stream temperatures in the basin result from riparian clearing, direct runoff from impervious surfaces, decreased groundwater recharge/discharge, and low flows. Dissolved oxygen, fecal coliform, temperature and concentrations of metals, including copper, lead, zinc, and chromium, have also been problematic (Ecology, electronic reference, Thornburgh and Williams 2000).

Three reaches of North Creek were added to the state's 303(d) list of polluted waters for low dissolved oxygen levels in 2008. These listings were based on a portion of samples exceeding the minimum standard of the 9.5 mg/L dissolved oxygen between 2003 and 2006 (Ecology, electronic reference). The lower reach of North Creek has been on the 303(d) list for temperature since 2004 because the temperature criterion for salmon spawning, rearing, and migrating (17.5°C or 63.5°F) was exceeded in every year from 1998-2002 (Ecology, electronic reference).

Several reaches of North Creek (Reaches 1, 2, 4, 5 and 6) are impaired by fecal coliform bacteria levels, and the southern reaches (Reaches 4-6) also have low dissolved oxygen concentrations. The North Creek Fecal Coliform Total Maximum Daily Load (TMDL) (Ecology 2001) was developed and adopted to identify concerns and develop a plan for reducing fecal coliform levels in those reaches and throughout the basin.

Still other reaches of North Creek are listed as Category 2 waters (waters of concern) for high levels of mercury, temperature, and pH (Ecology, electronic source). Minimum water quality standards and water quality impairments for the Cities' shoreline units are listed in Table 5. Further information on specific water quality impairments can be found on Ecology's website at <http://www.ecy.wa.gov/programs/wq/303d/index.html>.

Table 5. Minimum water quality standards and impairments by shoreline unit based on Ecology's (electronic source) Washington State Water Quality Assessment.

Water Quality Standard		Temperature	Dissolved Oxygen	Fecal Coliform	Mercury
Core salmon migration and rearing habitat and primary contact recreation		7-day average of the daily max. temp. less than 17.5°C	1 day minimum DO of 9.5 mg/L	Geometric mean of 100 colonies /100 ml, not more than 10 percent of all samples exceeding 200 colonies /100 mL	1 hr average of 2.1 mg/L or 4 d average of 0.012 mg/L
Supplemental salmon spawning and incubation habitat in Swamp and North Creeks		7-day average of the daily max. temp. less than 13°C from 11/15 to 5/15			
Reach	Reach Name	Water Quality Listing			
		Temperature	Dissolved Oxygen	Fecal Coliform	Mercury
1	North Creek – Thrasher's Corner (north of SR-524)			TMDL	
2	North Creek – Centennial Park			TMDL	
3	North Creek – Canyon Park				
4	North Creek – Fitzgerald (228 th Street SE to 240 th Street SE)	Water of Concern	303d	TMDL	
5	North Creek – North Creek Business Parks (240 th Street SE to I-405)	Water of Concern	303d	TMDL	
6	North Creek – Campus (I-405 to Sammamish River)	303d	TMDL	TMDL	Water of Concern
7	Swamp Creek – City of Bothell	Water of Concern	303d	TMDL	
8	Swamp Creek – City of Brier				
9-12	Sammamish River – Woodinville Drive, Brackett's Landing, Sammamish River Park, Downtown, and Bothell Way Corridor		303d	303d	
13-15	Sammamish River – Bothell Way Corridor, Wayne Golf Course to Bothell Business Park Floodway				

Channel Migration Zone

Reach 1, North Creek – Thrasher’s Corner. Potential for significant channel migration in Reach 1 is considered to be low due to established streambank vegetation, topographical constraints, and the built-out nature of areas adjoining the stream. Existing infrastructure would be protected.

Reach 2, North Creek - Centennial Park. The well-vegetated streambanks through this reach result in relatively stable banks and limit the *rate* of potential channel migration and associated erosion. However, since the reach lies in a low-gradient, depositional area which presently exhibits some channel braiding, channel locations, forms, and braiding patterns can be expected to evolve over time. Channel migration may occur due to deposition in existing channel sections associated with the low gradients, causing channel locations to shift, though this is not necessarily detrimental. The broad floodplains are largely depositional areas.

Reach 3, North Creek – Canyon Park. Upper Reach 3 is constrained by existing development and some areas of armoring which remain from past agricultural and commercial land uses. Dense bank vegetation is also present at many locations. Channel migration will likely be prevented in that area to protect existing development and associated infrastructure, though ongoing commitments for monitoring and maintenance amongst and between the City and private parties are needed.

The well-vegetated streambanks through the lower parts of Reach 3 also result in relatively stable banks and limit the rate of channel migration and associated erosion. Channel migration may occur due to low gradients and resulting deposition in the existing channel, and may also occur due to changes in meander patterns associated with bank erosion on the outsides of meander bends with deposition and bar formation on the insides. The broad floodplain areas provide for the deposition of fine sediments.

Reach 4, North Creek – Fitzgerald. Though the vegetation that exists along the streambanks through this area also contributes to bank stability and limits the rate of channel migration and associated erosion, some channel shifting can still be expected to occur. Furthermore, the North Creek channel through Reach 4 is fairly constrained by the surrounding topography, limiting the extent of adjoining floodplain areas as well as the channel migration zone. Thus any channel migration would be expected to be limited in both rate and degree. Adjoining development along Reach 4, particularly on the west side, would also be protected and so would limit the channel migration zone similarly to upper Reach 3.

Reach 5, North Creek – North Creek Business Parks. Reach 5 is constrained by existing development, constructed levees, and some areas of armoring which remain from past agricultural and commercial land uses. Like upper Reach 3, any significant channel migration will likely be prevented to protect existing development and associated infrastructure, though ongoing commitments for monitoring and maintenance amongst and between the City and private parties are needed. Dense bank vegetation to help slow and prevent migration is also present at many locations.

Reach 6, North Creek – Campus. According to the University of Washington Water Center Website, “The new channel was designed to allow the river to re-meander across the floodplain (within project constraints)...” (University of Washington, electronic source).

“Re-meander” can be interpreted to be synonymous with “migrate.” The well-vegetated streambanks and placed log structures through this area, coupled with lower gradients, result in relatively stable banks and limit the *rate* of channel migration and associated erosion. However, channel migration may occur over time due to the low gradients and resulting deposition in the existing channel. Migration may also occur due to changes in meander patterns associated with bank erosion on the outsides of meander bends with deposition and bar formation on the insides. As indicated above, such channel movement over time was intended by design and is not considered to be detrimental within limits. The broad floodplain areas are largely depositional.

4.1.2 Swamp Creek

Swamp Creek (WRIA 08.0059) has its origins in Snohomish County and flows southward into King County, before it empties into the Sammamish River at RM 0.6. Its drainage basin covers approximately 25 square miles, most of which is in unincorporated Snohomish County, but also included are the Cities of Everett, Lynnwood, Brier, Bothell, Mountlake Terrace, and Kenmore. Swamp Creek is approximately 11 miles in length (SCSWM 2002b).

Similar to North Creek, the Swamp Creek basin topography was shaped during the most recent period of glaciation, which left behind an undulating landscape of till, advance and recessional outwash, and lacustrine sediments. Most soils in the basin are a gravelly sandy type loam (Alderwood, Everett, and Norma soils) (Figure 11A, page C-24).

Swamp Creek historically supported runs of chinook, sockeye, kokanee, and coho salmon; steelhead and coastal cutthroat trout (Williams et al. 1975). More recently, spawning coho, sockeye, and kokanee have been noted just south of the King/Snohomish County line (Kerwin 2001). WDFW (2010) maps fall Chinook, sockeye, kokanee, coho, and winter steelhead in Swamp Creek through shoreline

jurisdiction and farther upstream. Of these species, Chinook salmon (*O. tshawytscha*) and steelhead trout (*O. mykiss*) are federally threatened and state candidate species. Coho salmon (*O. kisutch*) are a federal species of concern. And all of the salmonid species are Washington State Priority Species (Figure 15A, page C-32).

Similar to North Creek, within the Swamp Creek basin, channel complexity and connectivity with the floodplain and adjacent stream reaches are reduced due to road crossings/culverts, streambank hydromodification, channel incision and instability, and historical and on-going clearing and development in riparian areas. Clearing and development in the riparian corridors has reduced the extent of riparian forests and changed land cover from predominantly mature coniferous and mixed forests to young deciduous forest, and, in turn, from forest to impervious surface land cover. These changes in riparian conditions have led to a reduced amount of available wood that could function as LWD and limited in-stream large wood recruitment that contributes to channel complexity (Kerwin 2001).

Also similar to North Creek, it is estimated that the current 2-year flood discharge exceeds the historical 100-year discharge in Swamp Creek (SCSWM 1994a). The loss of floodplain area and wetlands in the basin, combined with water withdrawals and an increase in impervious surfaces has reduced water storage capacity. This has resulted in reduced summer low flow conditions, and many tributaries as well as mainstem sections run dry in the summer months (Kerwin 2002). Basin land cover alterations have resulted in changes to the basin's hydrology, resulting in peak flows of greater intensity and duration, lower summer flows, increased flashiness, over-widening of the stream channel, bank erosion, and scour of the streambed. This has led to the washout of LWD, reduction in the frequency and quality of pools, scour of salmon redds, and degradation of the aquatic macroinvertebrate communities (May et al. 1997 in Kerwin 2002).

High stream temperatures in Swamp Creek result from riparian clearing, direct runoff from impervious surfaces, decreased groundwater recharge/discharge, and low flows. These values exceed State designated standards and required temperatures for successful salmonid rearing (Thornburgh and Williams 2000). The lowest reach of Swamp Creek is on the 303(d) list for temperature based on readings collected from 1998-2002, and the reaches within and downstream of the Cities are listed as waters of concern (Category 2) (Ecology, electronic reference).

Several reaches within Swamp Creek, including the Swamp Creek- City of Bothell unit (shoreline unit 7), have not consistently met standards for dissolved oxygen and fecal coliform bacteria (Ecology, electronic reference). Based on

sampling results from 2000 to 2006, Swamp Creek south of 228th Street SW in the City of Bothell is 303(d)-listed for dissolved oxygen (Ecology, electronic reference; Figure 17A, page C-36). A TMDL for fecal coliform in Swamp Creek was adopted in 2006 to address concerns throughout the creek (Ecology 2006). Concentrations of metals in Swamp Creek, including copper, lead, zinc, and chromium, are some of the highest in Snohomish County (Thornburgh and Williams 2000).

4.1.3 Sammamish River

The Sammamish River (WRIA 08.0057) flows between the north ends of Lakes Sammamish and Washington and drains a watershed area of approximately 240 square miles. Historically, it overflowed its banks regularly and had a complex, highly sinuous, meandering channel that was somewhat longer than it is today. In 1891, the U.S. Army Corps of Engineers reported that the river was 17 miles long; today it has been shortened to about 13.5 miles long.

Throughout the 1900s, the river went through dramatic changes that reduced the complexity of the floodplain, including the lowering of Lake Washington, the channelization of the river, and the construction of drainage ditches in the river valley. Floodplain wetlands, side-channels, and spring-fed streams were affected. The elevation of Lake Washington was lowered by about 9 feet with the opening of the Chittenden Locks in 1916, also draining much of the Sammamish River corridor which had included extensive forested wetlands, especially near the mouth of North Creek (U.S. Department of Interior 1859). Prior to this, backwater effects from Lake Washington appear to have extended beyond the confluence with Little Bear Creek, including all of present-day Bothell (King County 1892).

Around the same time period, farmers in the Sammamish River Valley formed a drainage district that began to straighten the upper reach (east of the Bothell area) of the river dramatically. In 1962, the Corps began to systematically dredge the river, primarily as a flood control project, thus deepening the river 5 to 10 feet throughout most its length (Tetra Tech, Inc. 2002), hardening the river's banks, and dramatically decreasing its remaining connection to and interaction with the floodplain. Although a formal levee system was not constructed, the excavated material from dredging was "typically sidecast to fill in low spots (probable wetlands) and form short berms along the banks" on both sides of the channel through Bothell (Tetra Tech, Inc. 2002). These actions have greatly simplified the river and cut it off from its natural connections with the vast wetland complexes and off-channel habitats that historically characterized much of the river corridor. Many of the sidewall tributaries were left to enter the lowered river channel from hanging culverts that are impossible for fish to access, particularly during low flows (Kerwin 2001).

Discernible channel migration of the Sammamish River through the City of Bothell is not expected due primarily to the channelization (dredging) and armoring of the river accomplished by the Corps during the 1960s as described above. An exceptionally low channel gradient and associated low energy level available to drive bank erosion also greatly limit the risks of channel migration within the City. Lake Sammamish, located approximately 10 miles (16 kilometers) upstream, also provides a high level of natural and enhanced detention (via the King County weir at the Lake Sammamish outlet), which meters flood flows through the river channel within the City across a much extended time period to further reduce the potential for bank erosion and associated channel migration, however slow or limited.

Woody debris was also removed from the channel along with essentially all of the natural vegetation from the riverbanks. The Sammamish River is still classified as a navigable waterbody by the EPA, Corps, and U.S. Coast Guard, and FEMA is concerned with the roughness of the river and its ability to accommodate large flood flows. As such, recruitment of new woody debris has been largely precluded by these agencies which have continued to promote clearing of natural vegetation in riparian areas to maintain channel conveyance as required by the Corps. This maintained virtually LWD-free condition in turn affects the evaluation and analysis of ecological functions (as reported in Table 15, Section 4.3.8).

The lack of normal riparian characteristics further contributes to a loss of channel complexity, increased temperatures, and poor cover and forage for both aquatic and terrestrial wildlife (Kerwin 2001). This project did, however, meet its flood control objective and practically eliminated flooding throughout the Sammamish River Valley (King County Water and Land Resources, electronic source).

The lower reach of the river, extending downstream from Woodinville, has a much narrower direct drainage area than the upper. It includes the downtown core of Bothell and open space areas including the Wayne Golf Course and Bothell parkland along the Sammamish River Trail. The trail and a major King County sewer line which runs beneath it create potential constraints for restoration projects along their side of the river, mostly the north bank. From the standpoint of planning, the trail is also important for the public access, non-motorized transportation, and recreational uses it provides.

Chinook, coho, sockeye, kokanee, steelhead, and cutthroat are the salmonid fish species known to currently inhabit the Sammamish River system. Of these species, Chinook salmon (*O. tshawytscha*) and steelhead trout (*O. mykiss*) are federally threatened and state candidate species. Coho salmon (*O. kisutch*) are a federal species of concern, and all of the salmonid species are Washington State Priority Species (Figure 15B, page C-33). Kokanee are non-anadromous sockeye

and steelhead and cutthroat exhibit both sea-going and resident life histories. The lower reach includes two large salmon-bearing tributaries which are also Bothell shoreline streams: Swamp Creek and North Creek (Kerwin 2001).

Reaches of the Sammamish River are on the state's 303(d) list for temperature, fecal coliform, and dissolved oxygen (Ecology, electronic source; Figure 17B, page C-37). The mainstem Sammamish reaches extremely high water temperatures (by salmonid fish habitat standards) exceeding 17.5°C (63.5°F) during the summer and early fall, when Chinook and sockeye adults are migrating through it (Kerwin 2001). Historically, the river was probably always warmer in the summer and early fall than most Northwest rivers, since it is fed by the warm upper layers (the epilimnion) of Lake Sammamish and it flows slowly through a low-gradient valley (Kerwin 2001). However, the complex and heavily forested historic channel of the river would have provided far more shade than the river receives today (Kerwin 2001). Furthermore, the weir at Lake Sammamish reduces summer low flows in the Sammamish River (Kerwin 2001). Lower flows in the river during the late summer and early fall may in exacerbate water temperature problems (Martz, et al 1999 cited in Kerwin 2001).

During the course of WRIA 8 salmon planning efforts, it was observed that Sammamish River water temperatures within the vicinity of Bothell's Blyth Park were less than that predicted by modeling studies and expected based on the location of this reach near the bottom of the watershed (TetraTech 2002). Factors that may be responsible for lower temperatures in this reach include: 1) cool groundwater inputs from the adjacent Norway and Finn Hills which contain large amounts of ground water and aquifer storage; 2) the presence of significant mature vegetation and trees that shade the River from solar gain; and 3) a combination of groundwater input and shading of the River (TetraTech 2002). As part of the SMP update, the City is conducting water temperature monitoring along a stretch of the Sammamish River near Blyth Park in hopes of verifying the water temperature pattern and identifying any cause. Depending on the results of the study, special SMP regulations may be crafted to maintain processes or conditions that create the cooler waters.

4.2 Major Land Use Changes and Current Shoreline Condition

The City of Bothell was incorporated in 1909, while Brier was incorporated in 1965. By 2008, Bothell had grown to a population of approximately 32,000 while Brier had a population of approximately 6,300 people. Bothell and Brier contain sizable residential communities, while Bothell in addition is a regional employment center. Due to its significant transformation from a small town to a regional center of business, the City of Bothell land use pattern is a focus below.

At the time of incorporation, Bothell relied heavily upon the Sammamish River for transportation of goods and passengers, primarily as part of the logging industry. However, most boat traffic came to an end shortly thereafter, when Lake Washington was lowered in 1917. Logging then quickly declined and the economy mostly shifted to farming.

In the early 20th century, development occurred along major routes such as the road connecting Bothell to Seattle which followed along the Sammamish River and Lake Washington, as well as the Bothell-Everett Highway, generally following Horse Creek and North Creek, and Waynita Way. Houses and businesses concentrated along these routes and in downtown Bothell (City of Bothell 2009).

The downtown and corridor type development continued until the 1960s, when Interstate 405 was constructed, and there was much flat land adjacent to the interchanges. In the late 1970s and early 1980s, Bothell and Snohomish County updated their comprehensive plans to provide for the development of business parks in the North Creek Valley. The last two decades have seen residential, commercial and industrial development activity at a pace and magnitude not before seen in Bothell. In particular, the North Creek Valley has extensively developed, consisting of business parks, retail and services centers, and single- and multi-family residential development in a variety of configurations (City of Bothell 2009).

Since approximately 1980, Bothell has evolved from a bedroom community, sending its workers to Seattle, Everett and Bellevue, to a regional employment center that still provides a residential character (City of Bothell 2009).

As a result of intensive development over the last 20 and more years, most of the shorelines in both Brier and Bothell are in use for residential, commercial, and/or industrial/manufacturing purposes. These uses are interspersed with public and private open space and recreation. Land use in shoreline jurisdiction includes a mixture of single-family, multi-family, commercial, manufacturing, and open space uses. The majority of commercial uses are located along both banks of North Creek between State Route 524 and I-405. Residential uses dominate the majority of Swamp Creek through both Bothell and Brier. The Sammamish River is characterized by park/open space uses as well as residential and commercial uses. Both Cities' Comprehensive Plans call for shoreline land uses to remain virtually unchanged.

4.3 Analysis of Ecological Functions and Processes

Current ecological processes and functions of the Cities' shorelines are summarized in Tables 7 through 15, and establish a baseline for measurement of the SMPs' performance against the no net loss of ecological functions standard.

These tables are organized around Ecology's list of processes and functions for freshwater streams. The list includes the evaluation of four major processes: 1) hydrologic; 2) vegetation; 3) hyporheic; and 4) habitat.

Hydrologic processes pertain to the supply and movement of both ground and surface water within the environment, including sources, timing, amount, and direction. Hyporheic processes are related to and may be considered to be a special subset of hydrologic processes. Specifically, the hyporheic zone is the region beneath and lateral to stream beds where there is a mixing of shallow groundwater and surface water and where water percolates through the spaces between substrate and soil particles. Within the hyporheic zone, exchanges of water, nutrients, and organic matter occur between the surface stream and groundwater in response to variations in stream discharge, groundwater supply, channel form, and soil/substrate porosity. Upwelling subsurface water supplies stream organisms with nutrients while downwelling stream water provides dissolved oxygen and organic matter to microbes and invertebrates within the hyporheic zone, as well as water to plants growing along streambanks and within buffers.

These four primary processes are further broken down into the following functions which are in turn used to evaluate current reach performance (Table 6).

Table 6. Identification of Functions Evaluated for Each Major Process Based on Ecology's Shoreline Master Program Guidelines (WAC 173-26).

Stream Functions
1. Hydrologic Functions <ul style="list-style-type: none"> • Storing water and sediment • Transport of water and sediment • Attenuating flow energy • Developing pools, riffles, and gravel bars • Removing excess nutrients and toxic compounds • Recruitment of LWD and other organic material
2. Vegetative Functions <ul style="list-style-type: none"> • Temperature regulation • Water quality improvement • Slowing riverbank erosion; bank stabilization • Attenuating flow energy • Sediment removal • Provision of LWD and other organic matter
3. Hyporheic Functions <ul style="list-style-type: none"> • Removing excess nutrients and toxic compounds • Water storage and maintenance of base flows • Support of vegetation • Sediment storage
4. Habitat Functions <ul style="list-style-type: none"> • Physical space and conditions for life history • Food production and delivery

Assessment of each function by The Watershed Company is based upon both quantitative data results derived from the GIS inventory information described in Chapter 3; a qualitative assessment based on aerial photography, field inventory (where possible); and existing assessment information prepared by such entities as King County, WRIA 8 entities, and others. As described in Section 3.2, the shoreline has been divided into assessment units based on land use and ecological condition (see Exhibit 2 above and Figures 19A and B in Appendix C, pages C-43 & C-44). In the ensuing tables, each unit has been given an overall “rating” for ecological functions based on the available and relevant GIS information and the corresponding quantitative and qualitative evaluation.

Rating was completed using a “low” to “high” function scale, judged on a scale relative to other urban environments as opposed to an absolute scale including pristine habitats. It is not practical to identify quantitative ranges for the rating of each parameter because a comprehensive, quantitative field study of functions in each reach has not been conducted and existing quantitative information comes from mixed sources that are not always directly comparable. Further, the judgment calls are generally made based on the reach’s existing ability to perform a certain function, not whether the reach has the opportunity to perform that function. It is reasonable to assume that within the urbanized setting of the Cities of Bothell and Brier, development in the area provides sufficient opportunity to improve ecological conditions (e.g., water quality, habitat complexity, flood retention).

The level categories are:

- Low
- Low/Moderate
- Moderate
- Moderate/High
- High

No reach in its entirety received a High score. Many of the reaches scored High or Low for one or more individual functions, but these were generally offset by other functions which were performing at lower or higher levels. For purposes of ranking each reach’s relative function within the Cities of Bothell and Brier and assisting with later development of the Restoration Plan, each of the possible ratings was assigned a value of 1 through 5, with 5 representing high function and 1 representing low function. Each process group was averaged, and the averaged process scores were averaged to obtain a total reach score. The total reach scores are presented below, in order of highest to lowest function (Table 7) and are mapped in Figures 20A through 20L.

Table 7. Reach ranking order from highest to lowest function based on mean reach scores assigned in Tables 8 through 16.

Unit Number	Unit Name	Mean Score
6	North Creek – Campus (I-405 to Sammamish River)	4.04
2	North Creek – Centennial Park	3.65
3	North Creek – Canyon Park	3.38
5	North Creek – North Creek Business Parks (240 th Street SE to I-405)	3.35
4	North Creek – Fitzgerald (228 th Street SE to 240 th Street SE)	3.33
7 & 8	Swamp Creek – Cities of Bothell and Brier	2.85
1	North Creek – Thrasher's Corner (north of SR-524)	2.83
11	Sammamish River – Sammamish River Park	1.92
14 & 15	Sammamish River – Wayne Golf Course to Bothell Business Park Floodway	1.63
9, 10, 12, 13	Sammamish River – Woodinville Drive, Brackett's Landing, Downtown, and Bothell Way Corridor	1.50

4.3.1 North Creek – Thrasher's Corner (north of SR-524)

The North Creek – Thrasher's Corner assessment unit (Reach 1) consists of those areas of shoreline jurisdiction located north of the current Bothell City limits within the City's future annexation area (Exhibit 4, Figure 2A on page C-3). The assessment unit includes lands along both banks of North Creek and all associated wetlands. Reach 1 includes a total of approximately 0.22 mile of shoreline and 12.8 acres of total jurisdiction. An additional 17.88 acres of potentially associated wetlands extends upstream. Final determinations of association and wetland boundary will need to be made at the project level.

In 2003, 75% of samples in this unit had fecal coliform levels exceeding water quality standards, so this reach is included in the North Creek TMDL for fecal coliform bacteria (Ecology, electronic source). Other exceedances of tested water quality parameters (e.g., temperature, pH, dissolved oxygen) have not been documented (Ecology, electronic source), but this could be due to a lack of sampling of other parameters in this reach.



Exhibit 4. Aerial photo of North Creek – Thrasher's Corner assessment unit (Reach 1)

Table 8. Function Summary of North Creek – Thrasher's Corner (Reach 1).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Hydrologic	
Storing water and sediment	LOW/MODERATE: Within Reach 1, North Creek flows through a residential area with a moderately-wide and fairly well-vegetated buffer in most places. However, while streambanks are not high, the actual floodplain is fairly narrow (Figure 13A, page C-28). Out-of-channel flows do not tend to flood adjacent residential properties, being confined to the fairly narrow floodplain/buffer areas. As such, the floodplain storage function for water during flood events and for sediment following flood events is relatively low.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Transport of water and sediment	MODERATE/HIGH: The single-thread stream corridor has a moderate gradient and, though it has well-vegetated banks and moderate channel roughness, it appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment.
Attenuating flow energy	MODERATE/HIGH: With exceptions, this section of North Creek is lined with young forest and shrubby vegetation dominated by young alder. As such, channel roughness is moderately high and well-distributed, providing energy attenuation during high flows.
Developing pools, riffles, and gravel bars	MODERATE: This section of North Creek includes moderate-sized, but short-lived pieces of wood derived from the predominantly young alder forest it flows through. Sinuosity is moderate. These conditions are conducive to the formation of pools of moderate depth and complexity, with intervening riffles, and the formation of some gravelly bars on the inside of channel bends.
Removing excess nutrients and toxic compounds	MODERATE: The lack of a broad floodplain in this area results in incomplete biofiltration functions, and due to the urbanized nature of the basin, including upstream of Bothell, loading of nutrients and other pollutants is expected to be relatively high. The presence of densely-vegetated uplands and relatively stable vegetated banks help to filter out some nutrients and toxic compounds; however, many stormwater conveyance systems discharge directly to the stream reducing effective biofiltration in the stream buffers or on the floodplain in all reaches. Quality of discharge from such systems is more dependent on the efficacy of the treatment provided within the system itself.
Recruitment of LWD and other organic matter	MODERATE: Well-vegetated uplands through this reach and extending farther upstream in the potentially associated wetlands contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. In this case, <i>detritus</i> refers to the debris consisting of this decomposing leaf litter and other organic materials. However, trees along the banks and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
Vegetation	
Temperature regulation	MODERATE: The existing banks and buffers are fairly well vegetated and therefore provide a moderate amount of shading to the creek. These good shading conditions tend to decrease temperature and allow for increased dissolved oxygen.
Water quality improvement	MODERATE: Elevated fecal coliform levels in this reach provide an opportunity to improve water quality. Areas that are vegetated with trees, shrubs, grasses, emergent vegetation, and other riparian vegetation offer a fairly effective level of biofiltration for water moving to the creek through the uplands. However, as mentioned above, many stormwater conveyance systems discharge directly to the stream and so bypass the buffers. While buffer vegetation is fairly dense, relatively narrow floodplain areas limit the biofiltration of flood flows.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area result in relatively stable banks and limit the rate of channel migration and associated erosion.
Attenuating flow	MODERATE: The presence of significant adjacent streambank and

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
energy	riparian vegetation results in energy attenuation during high flows. In-stream wood is of only moderate size and is short-lived.
Sediment removal	MODERATE: As stated above, the lack of a wide floodplain limits the ability of buffer vegetation to filter fine sediments from flood flows already in the channel. But this buffer vegetation is able to remove sediment from locally generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the primarily alder trees along the banks and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. Fevold et al. (2001) found that the frequency of large woody debris in this reach was the highest among the reaches within the City of Bothell's jurisdiction at 96 pieces.
Hyporheic	
Removing excess nutrients and toxic compounds	MODERATE: Elevated fecal coliform levels in this reach provide an opportunity for hyporheic processes to improve water quality. The somewhat meandering nature of the channel and moderate bank height indicate the presence of a functional hyporheic zone with alluvial, somewhat pervious soils. However, the width of the zone is limited. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be moderate based on this limited width.
Water storage and maintenance of base flows	MODERATE: As above, the width of the zone of hyporheic flow is not high, limiting the potential for water storage and associated base-flow maintenance.
Support of vegetation	MODERATE/HIGH: Streambanks through the area appear to be low enough to allow vegetation to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: The narrow width of the hyporheic zone and the flashiness of North Creek flows tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
Habitat	
Physical space and conditions for life history	<p>LOW/MODERATE: Though a fairly well vegetated functional area of moderate width is present, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The vegetative community has been reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. This reduction in dense, but also in diverse, riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.</p> <p>Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.</p>
Food production and delivery	LOW/MODERATE: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are well-vegetated in places, overall diversity and complexity is diminished, thereby diminishing its value as wildlife habitat.
Summary	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Thrasher’s Corner assessment unit, the overall shoreline ecological function is considered MODERATE.

4.3.2 North Creek – Centennial Park

The North Creek – Centennial Park assessment unit (Reach 2) consists of those areas of shoreline jurisdiction located south of 208th Street SE (SR-524) and north of 214th Street SE along both banks of North Creek and all associated wetlands (Exhibit 5). The assessment unit includes a total of approximately 0.49 mile of shoreline and 77.11 acres of total jurisdiction. An additional 19.79 acres of potentially associated wetlands extends south of the primary Centennial Park wetland complex. Final determinations of association and wetland boundary will need to be made at the project level.

The upper portion of this reach and Filbert Creek, a tributary to this unit, are both included in the TMDL for fecal coliform bacteria (Ecology 2001). In 2003, 75% of samples in this upper portion of this unit had fecal coliform levels exceeding water quality standards, but other exceedances have not been measured and reported to date (Ecology, electronic source). Filbert Creek is also listed on the State’s 303(d) list for dissolved oxygen because 25% of the samples in 2003 did not meet water quality standards (Ecology, electronic source).

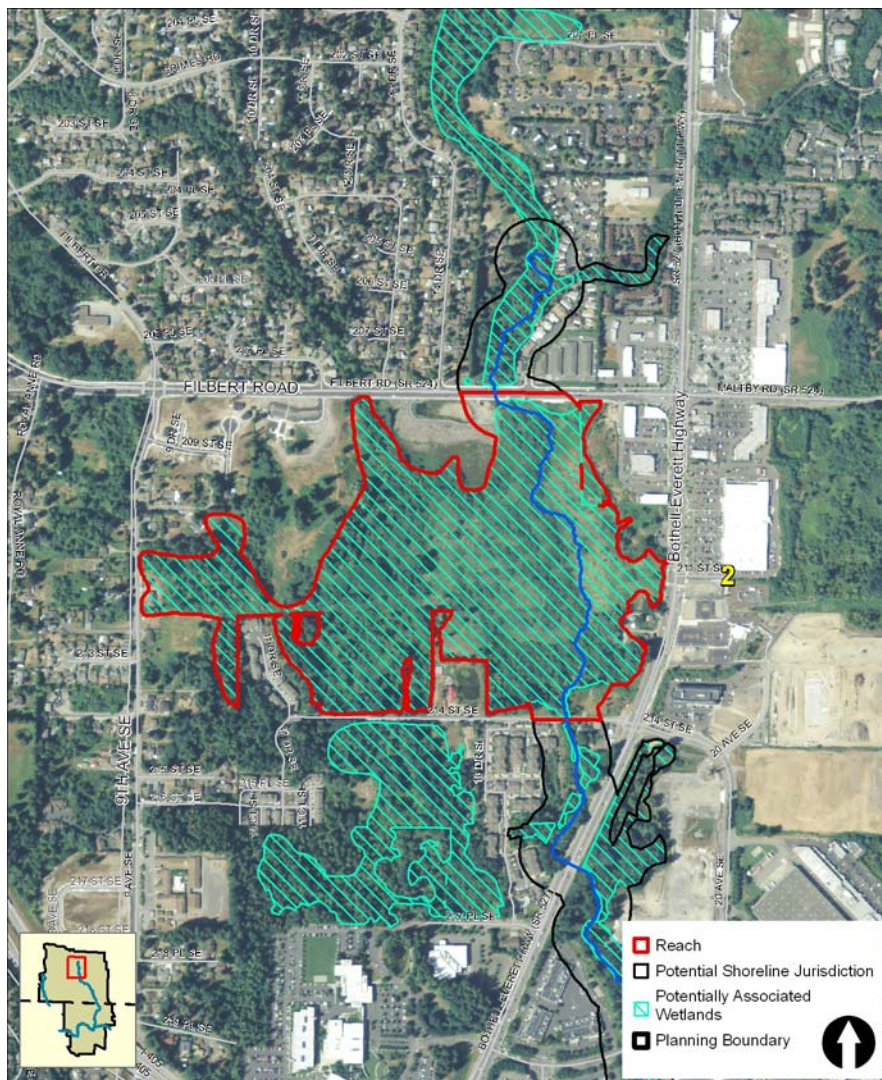


Exhibit 5. Aerial photo of North Creek – Centennial Park assessment unit (Reach 2)

Table 9. Function Summary of North Creek – Centennial Park (Reach 2)

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p>Hydrologic</p> <p>Storing water and sediment</p>	<p>HIGH: The mapped floodway (which is also considered to be floodplain) is fairly wide across this unit (Figure 13A, page C-28), and frequent out-of-channel flows and the vegetation present allow the over-bank storage function for both water and sediment to be relatively high. The streambanks are low and the extensive associated wetland areas across the floodway, and also extending well beyond it, are vegetated with shrubby vegetation which is effective at slowing the velocity of overbank flow and filtering out or allowing fine sediments to deposit. Wetland areas beyond the floodplain are also effective at storing water and filtering out locally-</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	generated sediments before the reach the active stream channel. Effective buffer widths are wide through the park and associated open space areas.
Transport of water and sediment	LOW/MODERATE: The broad floodplain areas in Centennial Park are less water and sediment transport sections and more storage areas. The importance of water and sediment transport through this unit is also low, however, since little infrastructure is present to be threatened by flooding or sedimentation. Storage rather than transport here benefits water quality and reduces flooding potential downstream.
Attenuating flow energy	HIGH: A combination of low, vegetated banks, a low stream gradient, and a broad, vegetated floodplain across this unit provides a high level of flow energy attenuation, especially at high flows.
Developing pools, riffles, and gravel bars	LOW/MODERATE: This low-gradient, wide floodplain section of North Creek is fairly low energy and so is more of a glide/run and less of a pool/riffle/bar area. Fevold et al. (2001) found that glides composed over 60% of this reach. Pool, riffle, and gravel bar formation is not extensive due to low energy and low levels of wood. This unit has relatively low potential for large wood recruitment, since the trees lining the banks or growing on the floodplain tend to be shrubby and/or young.
Removing excess nutrients and toxic compounds	HIGH: The broad floodplain across this unit allows for the effective biofiltration of overbank flood flows. The presence of wide and densely-vegetated buffers and relatively stable, vegetated banks also helps to filter nutrients and toxic compounds entering the creek locally. Because of water quality concerns and exceedance of state standards for fecal coliform and dissolved oxygen in this reach and its tributary, and because of the urbanized nature of the drainage basin, this ability to biofilter is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>Trees along the banks and throughout the buffer of the unit are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings. Wood may be removed from the stream in an attempt to protect infrastructure and reduce flooding and localized erosion.</p>
Vegetation	
Temperature regulation	LOW/MODERATE: Though the banks are generally well enough vegetated to be stable, forest cover is not consistently dense enough or tall enough to provide adequate shade. Portions of the stream flowing across the broad floodplain are partly exposed to direct sunlight, which tends to allow for temperature increases.
Water quality improvement	HIGH: The wide floodway and adjoining wetland and buffer areas across this unit, all vegetated with shrubs, grasses, emergent vegetation, and some trees, offer a fairly effective level of biofiltration

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area result in relatively stable banks and limit the rate of channel migration and associated erosion. The broad floodplains are largely depositional areas.
Attenuating flow energy	MODERATE/HIGH: Lower-gradient, broad floodplain areas as well as significant adjacent streambank and riparian vegetation results in energy attenuation during high flows. However, in-stream wood is of only moderate in size and tends to be short-lived, limiting the number, size, and persistence of log jams and other LWD formations.
Sediment removal	HIGH: As stated above, the presence of a wide, vegetated, flat floodplain allows buffer vegetation to filter fine sediments from flood flows already in the channel. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	LOW/MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, some sections are not tree-lined, and the primarily small, shrubby willow and other trees along the sections that are lined and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
Hyporheic	
Removing excess nutrients and toxic compounds	MODERATE: The low streambanks and broad floodplain areas throughout this unit contribute to a potentially broad hyporheic zone, however fine-grained soils may hinder hyporheic flows and function. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be reduced somewhat based on reduced soil permeability. (As stated above, biofiltration function associated with vegetation at the surface is expected to be high, however.)
Water storage and maintenance of base flows	MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for water storage and associated base-flow maintenance. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	HIGH: Low streambanks and wide floodplains through the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for subsurface sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-grained hyporheic soils tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
Habitat	
Physical space and conditions for life	MODERATE/HIGH: The broad, largely wetland floodplain areas in Centennial Park provide a diverse assemblage of habitat types for a

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
history	<p>variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Even so, as for nearly all other areas in the basin, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The density and diversity of riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted. Vegetation will contribute more to habitat function over time with maturity.</p> <p>Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.</p>
Food production and delivery	<p>MODERATE/HIGH: Food production from upland, wetland, and riparian areas originates largely from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically well-vegetated and such vegetated areas are wide in places, overall diversity and complexity is diminished, thereby diminishing its value as wildlife habitat.</p>
Summary	<p>Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Centennial Park assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.</p>

4.3.3 North Creek – Canyon Park

The North Creek – Canyon Park assessment unit (Reach 3) consists of those areas of City lands located within shoreline jurisdiction south of 214th Street SE and north of 228th Street SE along both banks of North Creek (Exhibit 6). The assessment unit includes a total of approximately 1.42 miles of shoreline and 87.45 acres of total jurisdiction.

No water quality impairments have been measured and reported within this reach itself; however, tributaries to this reach are 303(d) listed for dissolved oxygen and included in the TMDL for fecal coliform (Ecology 2001) based on exceedances observed in 2003 and 2004.

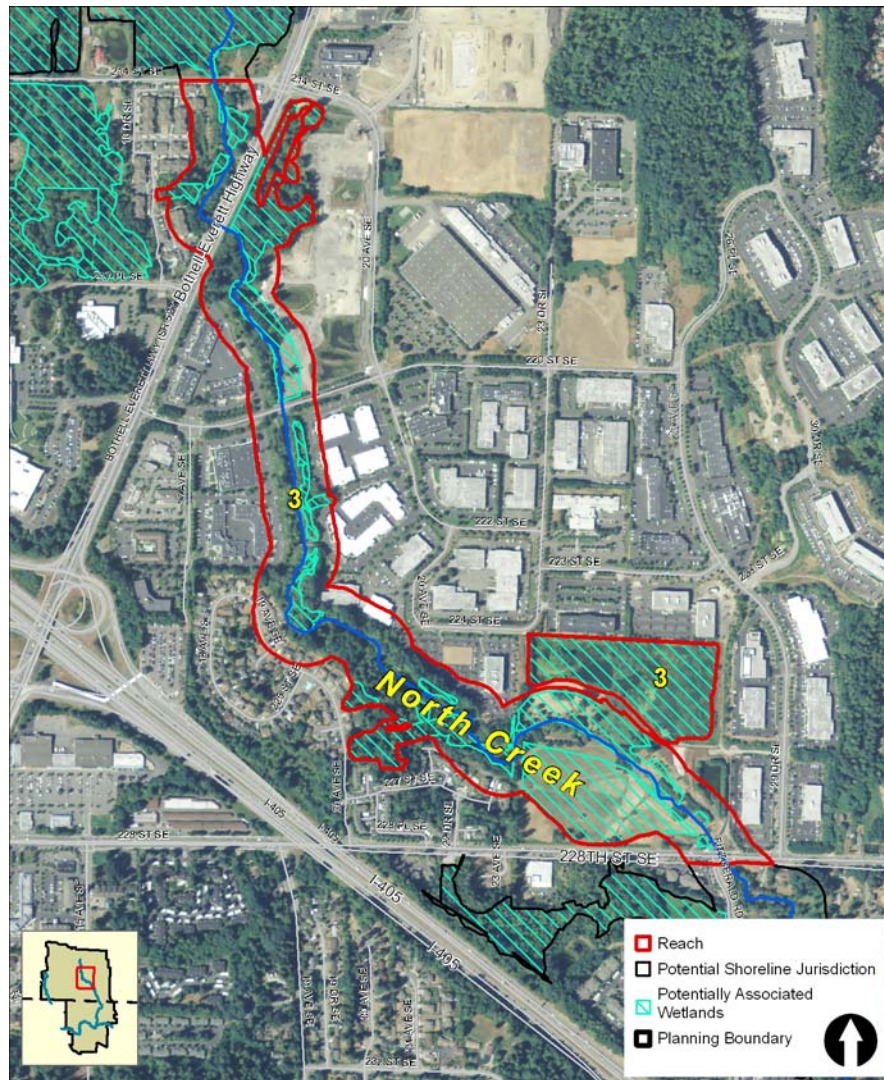


Exhibit 6. Aerial photo of North Creek – Canyon Park assessment unit (Reach 3)

Table 10. Function Summary of North Creek – Canyon Park (Reach 3).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
<p>Hydrologic</p> <p>Storing water and sediment</p>	<p>MODERATE/HIGH: Within the Canyon Park Assessment Unit, North Creek flows primarily through business park areas extending downstream of the Bothell-Everett Highway (SR 524), and some broad, open space areas downstream of the business park approaching 228th Street SE. Some limited residential areas are also included just upstream and downstream of the Canyon Park Business Center, including at the upstream end of the unit between 214th Street SE and SR 524. Effective buffer widths vary widely across this unit, being very wide through the open space areas at the lower end and</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	quite narrow through the central portion in the business park downstream from 220 th Street SE (Figure 16A, page C-34). The floodplain is quite broad and well-functioning at the downstream end of this unit (Figure 13A, page C-28), and frequent, out-of-channel flows in that area allow the floodplain storage function for both water and sediment to be moderately high for the unit as a whole.
Transport of water and sediment	MODERATE: The North Creek channel through the central, business park portion of this unit has a moderate gradient with armored banks in places. It appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment. In contrast, the broad floodplain areas approaching 228 th Street SE are less water and sediment transport areas and more storage areas.
Attenuating flow energy	MODERATE/HIGH: A combination of vegetated banks throughout and broad floodplain areas in some sections contribute to a fairly high level of flow energy attenuation at high flows.
Developing pools, riffles, and gravel bars	LOW/MODERATE: This section of North Creek has relatively low potential for large wood recruitment. Through the business park, the channel is constrained, sinuosity is not high, and gravel bar formation is not extensive. Low-gradient sections through the wide floodplain areas at the downstream end are more glide/run and less pool/riffle areas.
Removing excess nutrients and toxic compounds	MODERATE: The broad floodplain areas at the downstream end of this unit allow for the biofiltration of overbank flood flows. The presence of relatively stable, vegetated banks along many sections also helps to filter nutrients and toxic compounds entering the creek locally, keeping in mind, though, that many stormwater conveyance systems discharge directly to the stream. Because of water quality concerns with fecal coliform and low dissolved oxygen upstream and because of the urbanized nature of the basin, this ability to biofilter is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>However, trees along the banks and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings. Wood may be removed from the stream in an attempt to protect infrastructure and reduce flooding and localized erosion.</p>
Vegetation	
Temperature regulation	LOW/MODERATE: Though the banks are generally well enough vegetated to be stable, forest cover is not consistently dense enough or tall enough to provide adequate shade. In particular, the broad floodplain areas at the downstream end of this unit are partly exposed to direct sunlight. These exposed conditions tend to allow for temperature increases.
Water quality	MODERATE/HIGH: Broad floodplain buffer areas at the downstream

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
improvement	end of this unit, vegetated with shrubs, grasses, emergent vegetation, and some trees, offer a fairly effective level of biofiltration for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: Upper Reach 3 is constrained by existing development and some areas of armoring which remain from past agricultural and existing commercial land uses. Dense bank vegetation is also present at most locations. The well-vegetated streambanks through the lower parts of Reach 3 result in relatively stable banks and limit the rate of channel migration and associated erosion. The broad floodplain areas are largely depositional.
Attenuating flow energy	MODERATE/HIGH: The presence of lower-gradient, broad floodplain areas as well as significant adjacent streambank and riparian vegetation results in energy attenuation during high flows. However, in-stream wood is of only moderate size and tends to be short-lived, limiting the number, size, and persistence of log jams and other LWD formations.
Sediment removal	MODERATE/HIGH: As stated above, the presence of wide floodplain areas allows buffer vegetation to filter fine sediments from flood flows already in the channel. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek. (Again, not all stormwater moves through the buffers since most stormwater conveyance systems discharge more or less directly to the stream and so bypass them.)
Provision of LWD and other organic matter	LOW/MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, some sections are not tree-lined, and the primarily alder and willow trees along other bank sections and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
Hyporheic	
Removing excess nutrients and toxic compounds	MODERATE: The low streambanks and broad floodplain areas at the downstream end of this unit contributes to a potentially broad hyporheic zone, however fine-grained soils may hinder hyporheic flows and function. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be reduced somewhat based reduced soil permeability. (As stated above, biofiltration function at the surface is expected to be high, however.)
Water storage and maintenance of base flows	MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for water storage and associated base-flow maintenance. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	MODERATE/HIGH: Low streambanks and wide floodplains through portions of the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	grained hyporheic soils tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
Habitat	
Physical space and conditions for life history	<p>MODERATE/HIGH: The broad, partially wetland floodplain areas in the open space areas approaching 228th Street SE at the lower end provide a diverse assemblage of habitat types for a variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Even so, as for nearly all other areas in the basin, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The density and diversity of riparian vegetation is a limiting factor for terrestrial species (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.</p> <p>Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.</p>
Food production and delivery	MODERATE/HIGH: Food production from upland, wetland, and riparian areas originates primarily from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provides food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically well-vegetated and such vegetated areas are wide in places, overall diversity and complexity is diminished, thereby diminishing its value as wildlife habitat.
Summary	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Canyon Park assessment unit, the overall shoreline ecological function is considered MODERATE.

4.3.4 North Creek – Fitzgerald (228th Street SE to 240th Street SE)

The North Creek – Fitzgerald assessment unit (Reach 4) consists of those areas of City lands located within shoreline jurisdiction south of 228th Street SE and north of 240th Street SE along both banks of North Creek (Exhibit 7). The assessment unit includes a total of approximately 1.12 mile of shoreline and 72.05 acres of total jurisdiction. This is a section of North Creek and a regulatory planning area identified as the North Creek Fish and Wildlife Critical Habitat Protection Area (NCFWCHPA) which have been identified by various studies as containing superior habitat as well as a high potential for further habitat improvements and recovery. However, these increased protections do not translate to immediate improvements on the ground and will take some time to take more or less full effect.

This reach is on the state's 303(d) list for low levels of dissolved oxygen, although sampling has shown a gradually decreasing trend in the proportion of samples exceeding standards from initial sampling between 1992-1995 (Thornburg 1996 cited by Ecology, electronic reference) and sampling from 2003-2006 (Ecology, electronic reference). This reach is also included in the TMDL for fecal coliform bacteria in North Creek (Ecology 2001). It is also listed as a water of concern for temperature because of excursions above water quality standards in 5% of samples between 1992 and 1998 (Thornburg 1996 and Snohomish County 1998 cited in Ecology, electronic reference).

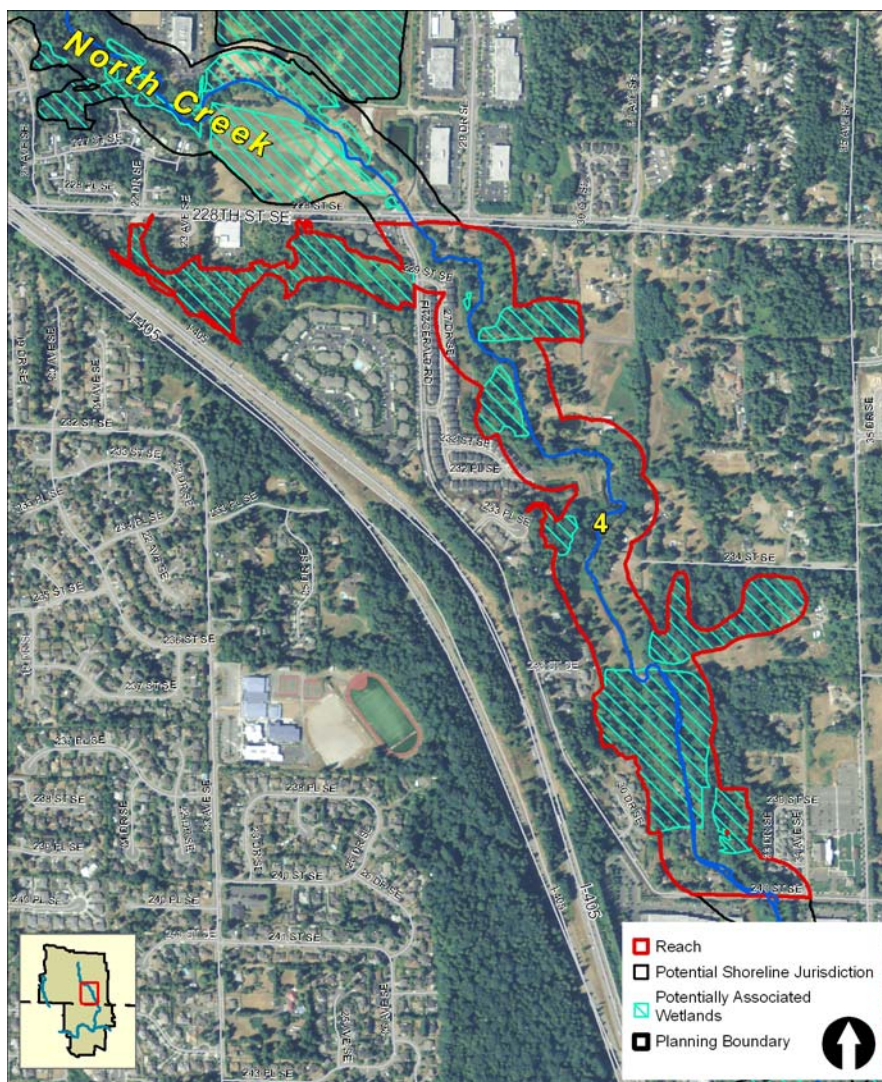


Exhibit 7. Aerial photo of North Creek – Fitzgerald assessment unit (Reach 4)

Table 11. Function Summary of North Creek – Fitzgerald (Reach 4).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Hydrologic	
Storing water and sediment	MODERATE: Within Reach 4, North Creek flows through a scattered, established residential area with some areas of newer, much higher density housing along the west side, between Fitzgerald Road and the creek (Figure 5A, page C-12). The creek has a vegetated buffer of varying effective width, with some areas of mowed grass still near the creek in places. While the immediate streambanks are not high, ground rises moving away from the creek and the actual floodplain is fairly narrow. Out-of-channel flows do not tend to flood adjacent residential properties, being confined to the fairly narrow floodplain/buffer areas (Figure 13A, page C-28). As such, the floodplain storage function for both water during and sediment following flood events is fairly average.
Transport of water and sediment	MODERATE/HIGH: The single-thread stream corridor has a moderate gradient and, though it has well-vegetated banks in places and moderate channel roughness, it appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment.
Attenuating flow energy	MODERATE/HIGH: This section of North Creek is lined with trees and shrubby vegetation along much of its length, though there are still some yard and other open grassy areas in others. As such, channel roughness is moderately high, providing energy attenuation during high flows.
Developing pools, riffles, and gravel bars	MODERATE/HIGH: This section of North Creek includes some moderate-sized, pieces of wood derived from the young, mixed forest it flows through. Sinuosity is moderate. These conditions are conducive to the formation of pools of moderate depth and complexity, with intervening riffles, and the formation of some gravelly bars on the inside of channel bends.
Removing excess nutrients and toxic compounds	MODERATE: The lack of a broad floodplain in this area puts an upper cap on the level of biofiltration function and loading of nutrients and other pollutants is expected to be relatively high given the high levels of fecal coliform and low levels of dissolved oxygen in the reach (Ecology, electronic reference). The presence of moderately well-vegetated buffers and relatively stable banks help to filter out some of the nutrients and toxic compounds of local origin.
Recruitment of LWD and other organic matter	MODERATE: Moderately well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. Additional such materials arrive from upstream. However, trees along the banks and throughout the buffer are still fairly small and of varying density, though this is expected to improve with time. Those which are deciduous have a fairly short functional lifespan when and if they do fall into the stream.
Vegetation	
Temperature regulation	MODERATE: The forest cover is not yet consistently dense enough or tall enough to provide optimal shade. These partially exposed conditions tend to allow for temperature increases, which are a concern given the known history of temperature exceedances in this

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	reach (Ecology, electronic reference). Regulatory requirements targeting this area will likely improve this condition over time.
Water quality improvement	MODERATE: Buffer areas are generally vegetated with trees, shrubs, though there are also some actively or passively landscaped mowed grass and yard areas. This vegetation offers a moderate level of biofiltration for water moving to the creek through the buffers. Also, relatively narrow floodplain areas limit the biofiltration of flood flows.
Slowing riverbank erosion; bank stabilization	MODERATE: Though the vegetation that exists along the streambanks through this area contributes to bank stability and limits the rate of channel migration and associated erosion, there is some potential for channel shifting.
Attenuating flow energy	MODERATE: The presence of moderate-density streambank and riparian vegetation results in energy attenuation during high flows. In-stream wood is of only of moderate size and much of what is present is short-lived.
Sediment removal	LOW/MODERATE: As stated above, the lack of a wide floodplain limits the ability of buffer vegetation to filter fine sediments from flood flows already in the channel. Buffer vegetation is able to remove some of the sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the trees along the banks and throughout the buffer are presently of only moderate density and size. Many are fairly small deciduous trees such as alder with a fairly short functional lifespan when and if they do fall into the stream.
Hyporheic	
Removing excess nutrients and toxic compounds	MODERATE: The somewhat meandering nature of the channel and moderate bank height indicate the presence of a functional hyporheic zone with alluvial, somewhat pervious soils. However, the width of the zone is limited. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be moderate based on this limited width.
Water storage and maintenance of base flows	MODERATE: As above, the width of the zone of hyporheic flow is not high, capping the potential for water storage and associated base-flow maintenance.
Support of vegetation	MODERATE/HIGH: Streambanks through the area appear to be low enough to allow buffer vegetation to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: The narrow width of the hyporheic zone and the flashiness of North Creek flows tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
Habitat	
Physical space and conditions for life history	MODERATE/HIGH: Though a somewhat well-vegetated and functional buffer area of moderate width is present, habitat in and along North Creek through this unit has still been reduced in quality, quantity, and complexity compared to its original condition. As mentioned, regulatory changes specific to this area are expected to

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	<p>result in improvements, but these will take time. However, though the vegetative community has been reduced somewhat in scale, the area is less urbanized compared to other areas of the City and includes forested slopes with varying levels of accumulated downed wood and snags, providing places for various wildlife species to find cover or suitable nesting and rearing sites. The prevalence of dense, but also diverse, riparian vegetation affects terrestrial species' (birds, mammals, amphibians) use of the shoreline, since such dense vegetation provides cover, food, nesting sites, travel corridors,.</p> <p>Within the channel itself, additional and more persistent wood would help provide cover and complexity to the existing pools and riffles; substrate quality is favorable for use by salmonid fish.</p>
Food production and delivery	<p>MODERATE/HIGH: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though the density of streamside vegetation could be improved, well-vegetated areas remain in places to provide overall diversity and complexity for wildlife habitat.</p>
Summary	<p>Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Fitzgerald assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.</p>

4.3.5 North Creek – North Creek Business Parks (240th Street SE to I-405)

The North Creek – Business Park assessment unit (Reach 5) consists of those areas of City lands located within shoreline jurisdiction south of 240th Street SE and northeast of I-405 along both banks of North Creek (Exhibit 8). The assessment unit includes a total of approximately 1.25 miles of shoreline and 77.25 acres of total jurisdiction. An additional 4.34 acres of wetlands may be associated via ditched or piped hydrologic connections to a complex east of the reach. Final determinations of association and wetland boundary will need to be made at the project level.

According to GeoEngineers, Inc. (2008), the levees in the Schnitzer North Creek and Bothell Business Park were constructed and certified in 1994 for a 100-year event of 1,400 cfs. However, recalculations of the new 100-year flow resulted in an increase to 1,700 cfs. Accordingly, portions of the levees required 1 ½ to 2 feet of new fill to contain the new 100-year event with an additional foot or more of height added beyond the required 3 feet of freeboard to provide additional

protection against increasing 100-year floods and factor in levee settling (GeoEngineers, Inc. 2008).

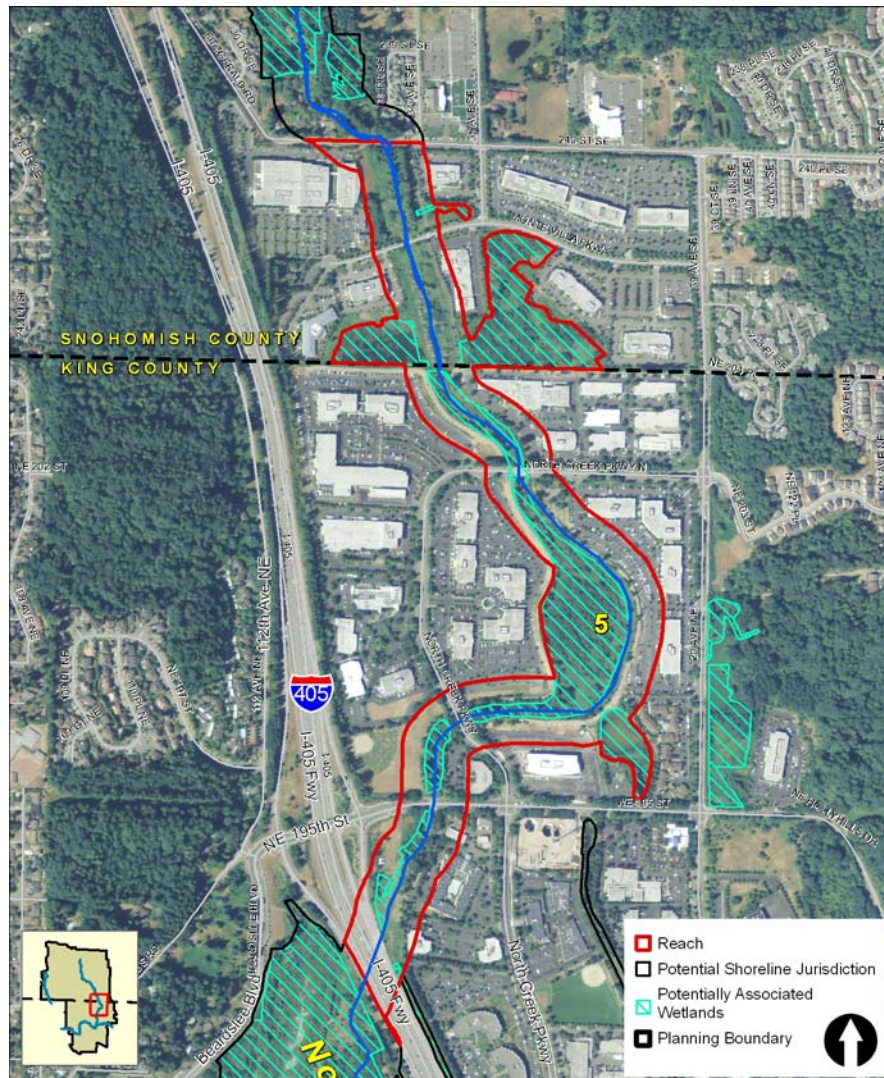


Exhibit 8. Aerial photo of North Creek – North Creek Business Parks assessment unit (Reach 5)

While levees are meant to protect uses and developments on the upland side, they can also result in increased flood damages if they fail. The constrained flood is higher and has increased energy, such that the impact of the water passing through a levee breach can have greater destructive impacts than a non-constrained flood of equal volume might have had (Snohomish County 2001).

The upper portion of this unit is on the state's 303(d) list for low levels of dissolved oxygen, although sampling has shown a gradually decreasing trend in the proportion of samples exceeding standards from initial sampling between 1992-1995 (Thornburg 1996 cited by Ecology, electronic reference) and sampling

from 2003-2006 (Ecology, electronic reference). The upper portion of this unit is also included in the TMDL for fecal coliform bacteria in North Creek (Ecology 2001). It is also listed as a water of concern for temperature because of excursions above water quality standards in 5% of samples between 1992 and 1998 (Thornburg 1996 and Snohomish County 1998 cited in Ecology, electronic reference). Although no exceedances for water quality parameters (e.g., temperature, dissolved oxygen, fecal coliform, pH) have been documented in the lower portion of this reach, that could be a result of limited sampling stations along the creek, and upstream impairments likely transfer through the entire unit.

Table 12. Function Summary of the North Creek – North Creek Business Parks (Reach 5)

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Hydrologic	
Storing water and sediment	MODERATE: Within Reach 5, North Creek flows successively through several business park areas developed on a broadening North Creek and Sammamish River floodplain as the creek enters the Sammamish River Valley (Figures 5A & B, pages C-12 & C-13). This unit extends between Interstate 405 at the downstream end to 240 th Street SE at the upstream end. Effective buffer widths are fairly uniform across this unit, as planned in conjunction with business park development, with two wider areas incorporating fairly extensive riparian wetlands. One is on the right bank on the Snohomish County side of the county line (Monte Villa park) and the second also mostly on the right bank extending downstream of North Creek Parkway N. (Koll North Creek park). There has been a large overall historic loss in active floodplain along this section due to construction of levees and the developments they protect (Figures 13A & B, pages C-28 & C-29). The reduced extent of the active floodplain has in turn reduced its capacity to provide hydrologic benefits. However, where retained, the floodplain is generally well-functioning across this unit, and frequent, out-of-channel flows allow the floodplain storage function for both water and sediment to be relatively high for the unit as a whole.
Transport of water and sediment	LOW/MODERATE: The North Creek channel through the Business Park unit has a well defined channel through wetland and floodplain areas and a flattening gradient. Banks are armored banks in places, especially at the upstream end, associated with previous agricultural uses. The reduced gradient along this unit allows flood flows to slow and spread across portions of the floodplain where finer sediments are stored. The reduced gradient allows some of the coarser sediments to be deposited within the channel.
Attenuating flow energy	MODERATE/HIGH: A combination of diminishing channel gradient, vegetated banks throughout, and broad floodplain areas in some sections contribute to a fairly high level of energy attenuation of high flows.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Developing pools, riffles, and gravel bars	LOW/MODERATE: A low-gradient section in the central part of this unit also has a wide floodplain and the channel consists more of glide/run and less pool/riffle areas. Little gravel bar formation occurs along this central portion. More pool/riffle sequencing with associated gravel bar formation occurs near each end of this unit. This section of North Creek has relatively low potential for large wood recruitment (see below), and such wood tends to facilitate and accentuate pool/riffle sequencing.
Removing excess nutrients and toxic compounds	MODERATE/HIGH: The broad floodplain areas, especially near the central part of this unit, allow for the biofiltration of overbank flood flows. The presence of wide and densely-vegetated buffers and relatively stable, vegetated banks along many sections also helps to filter nutrients and toxic compounds entering the creek locally. Again, due to the urbanized nature of the basin, and documented water quality concerns with fecal coliform and dissolved oxygen, loading of nutrients and other pollutants is expected to be relatively high, and so this ability to biofilter is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>Trees along the banks and throughout the buffer are largely fairly small, shrubby deciduous trees, including willow, alder, and cottonwood, with a fairly short functional lifespan when and if they do fall into the stream. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings. Wood may be removed from the stream in contributing areas upstream an attempt to protect infrastructure and reduce flooding and localized erosion.</p>
Vegetation	
Temperature regulation	LOW/MODERATE: Though the banks are generally well enough vegetated to be stable, forest cover is not consistently dense enough or tall enough to provide adequate shade. In particular, only relatively shrubby vegetation tends to grow along the broad floodplain area in the central portion of this unit, where the channel is partly exposed to direct sunlight. These exposed conditions tend to allow for temperature increases.
Water quality improvement	MODERATE/HIGH: Broad floodplain buffer areas in the central part of this unit vegetated with shrubs, grasses, emergent vegetation, and some trees, offer a fairly effective level of biofiltration for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area, coupled with lower gradients, result in relatively stable banks and limit the rate of channel migration and associated erosion. Where present, the broad floodplains are largely depositional areas.
Attenuating flow energy	MODERATE: The presence of lower-gradient, broad floodplain areas as well as significant adjacent streambank and riparian vegetation

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	results in energy attenuation during high flows. However, in-stream wood is of only moderate size and tends to be short-lived, limiting the number, size, and persistence of log jams and other LWD formations.
Sediment removal	MODERATE/HIGH: As stated above, the presence of a wide floodplain and lower channel gradient allows buffer vegetation to filter fine sediments from flood flows already in the channel. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	LOW/MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, some sections are not tree-lined, and the primarily alder and willow trees along other bank sections and throughout the buffer are fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. In 2001, LWD loading in this reach was low, 19 pieces/km (Fevold et al. 2001).
Hyporheic	
Removing excess nutrients and toxic compounds	MODERATE: The low streambanks and broad floodplain areas in the central portion of this unit contribute to a potentially broad hyporheic zone there, however fine-grained soils including areas of peat may hinder hyporheic flows and function. The natural potential for hyporheic removal of excess nutrients and toxic compounds is expected to be reduced somewhat based reduced soil permeability. (As stated above, biofiltration function at the surface is expected to be high, however.)
Water storage and maintenance of base flows	MODERATE: As above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for water storage and associated base-flow maintenance. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	HIGH: Low streambanks and wide floodplains through portions of the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: As above, the permeability of fine-grained hyporheic soils, which include areas of peat, is not expected to be high, limiting the potential for sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-grained hyporheic soils tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
Habitat	
Physical space and conditions for life history	MODERATE/HIGH: The broad, partially wetland floodplain areas in the central part of this unit provide a diverse assemblage of habitat types for a variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Even so, as for nearly all other areas in the basin, habitat in and along North Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The density and diversity of riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	Within the channel itself, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.
Food production and delivery	MODERATE/HIGH: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically well-vegetated and such vegetated areas are wide in places, overall diversity and complexity is diminished from its original condition, thereby diminishing its value as wildlife habitat.
Summary	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – North Creek Business Parks assessment unit, the overall shoreline ecological function is considered toward the higher end of the MODERATE range.

4.3.6 North Creek - Campus (I-405 to Sammamish River)

The North Creek – Campus assessment unit (Reach 6) consists of those areas of City lands located along both banks of North Creek west of Interstate-405 and north of its confluence with the Sammamish River (Exhibit 9). The assessment unit includes a total of approximately 0.86 mile of shoreline and 83.33 acres of total jurisdiction, largely on the campus of Cascadia Community College / University of Washington – Bothell (CCC/UW-B).

This reach is the site of a large-scale restoration mitigating impacts to wetlands resulting from development of the campus. Approximately 58 acres of riverine and floodplain ecosystem was restored by reconnecting the Creek to portions of its historical floodplain through creation of a new primary and secondary channel. As former grazed pasture land prior to implementation of the large-scale restoration project in 1998, the young, largely planted forest is still in the process of growing and developing into mature riverine or riparian forest.

The lower portion of this unit is 303(d) listed for temperature based on unpublished data from King County showing that temperature standards were exceeded every year from 1998-2002 (Ecology, electronic reference). This unit is included in the North Creek TMDL for fecal coliform, and correspondingly, for dissolved oxygen (Ecology 2001). The state also listed this unit as a water of concern (Category 2) for mercury concentrations (Ecology, electronic reference).

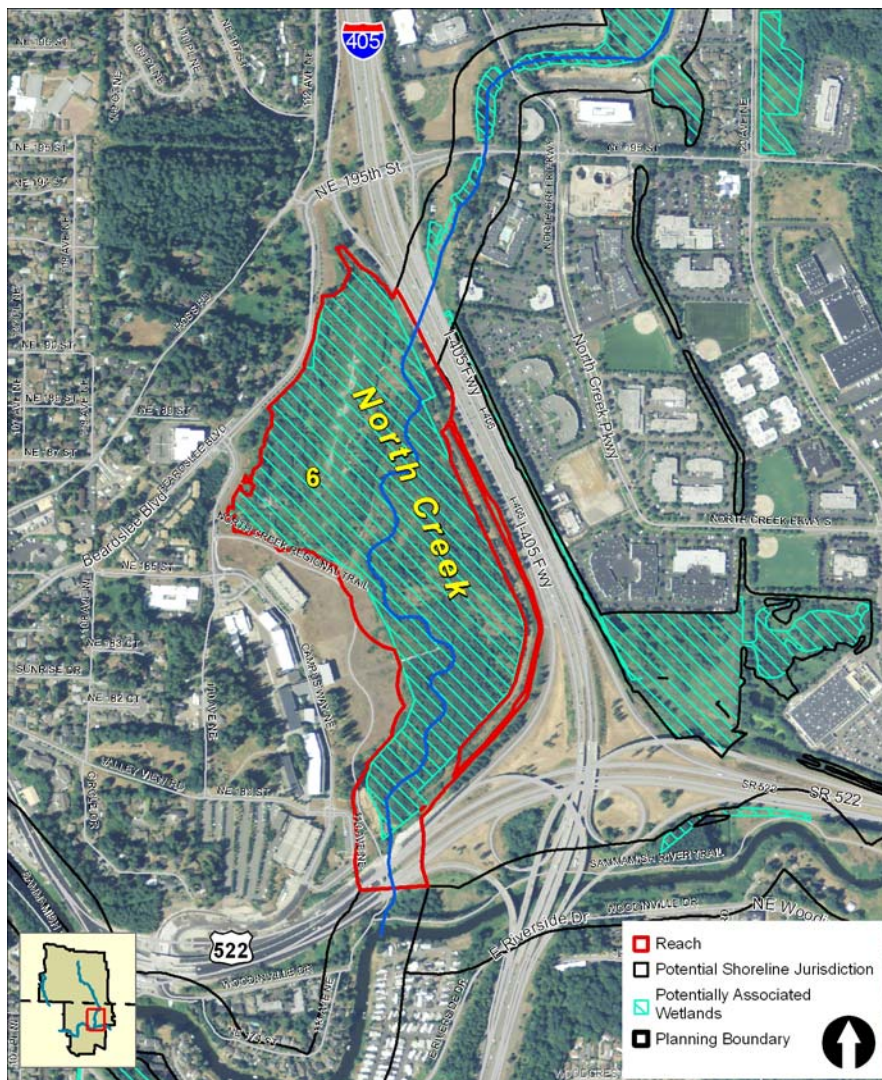


Exhibit 9. Aerial photo of North Creek - Campus assessment unit (Reach 6)

Table 13. Function Summary of North Creek – Campus (Reach 6).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Hydrologic	
Storing water and sediment	HIGH: Within Reach 6, North Creek flows through a broad floodplain area with extensive riparian wetlands within the Sammamish River Valley (Figure 13B, page C-29). This area was formerly diked and used as agricultural land but is now being restored as habitat. University campus areas lie on the sloped upland areas west of the floodplain. This unit extends along North Creek downstream from Interstate 405 to the mouth at the Sammamish River. The restored floodplain is generally well-functioning across this unit, and frequent, out-of-channel flows allow the floodplain storage function for both

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	water and sediment to be quite high for the unit as a whole, likely the highest of anywhere along North Creek.
Transport of water and sediment	LOW/MODERATE: The North Creek channel through the UW unit has a low-gradient channel through broad floodplain and wetland areas. The reduced gradient and low banks along this unit allow flood flows to slow and spread across the floodplain where both water and fine sediments are stored. Some of the coarser sediments are also presumably deposited within the channel since they cannot ultimately be carried by the low-gradient Sammamish River. However, the importance of the transport of water and sediment through this unit is diminished, as it is intended to function as a habitat area and these functions are not needed to protect infrastructure.
Attenuating flow energy	MODERATE/HIGH: A combination of low channel gradient, vegetated banks throughout, and overall broad floodplain areas contribute to a fairly high level of energy attenuation of high flows.
Developing pools, riffles, and gravel bars	MODERATE/HIGH: Though this section of North Creek still has a relatively low potential for large wood recruitment due to the young age of the trees growing along the banks, large numbers of logs have been placed in conjunction with restoration efforts. Such wood tends to facilitate and accentuate pool/riffle sequencing. Furthermore, the low gradient is conducive to gravel deposition to form bars and riffles where logs are not present to provide sufficient turbulence to prevent such deposition.
Removing excess nutrients and toxic compounds	HIGH: The broad floodplain areas throughout this unit allow for the effective biofiltration of overbank flood flows. The presence of wide and densely-vegetated buffers and relatively stable, vegetated banks also helps to filter nutrients, bacteria, and toxic compounds entering the creek locally. Again, given the TMDL for high levels of fecal coliform in this reach and the urbanized nature of the basin, biofiltration capacity is important.
Recruitment of LWD and other organic matter	<p>MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Well-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain.</p> <p>Trees along the banks and throughout the buffer are fairly small, shrubby deciduous trees, including willow, alder, and cottonwood, with a fairly short functional lifespan when and if they do fall into the stream. The frequency of LWD was very low, only 3 pieces/km in 2001 (Fevold et al. 2001), but as a restored and revegetated reach, LWD recruitment potential is expected to increase over time. The supply of LWD from farther upstream is also expected to be impaired due to the highly-developed nature of the basin and pass-through transport issues at road crossings and the presence of FEMA-certified levees in other portions of the watershed which are required to be LWD-free. Wood may be removed from the stream in contributing areas upstream an attempt to protect infrastructure and reduce flooding and localized erosion.</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Vegetation	
Temperature regulation	MODERATE/HIGH: This reach is presently impaired by high water temperatures (Ecology, electronic reference). Though the banks are generally stabilized by vegetation, forest cover is still immature and not consistently dense enough or tall enough to provide optimal shade. Though this condition may not be apparent from ground level, as from a drive-by along I-405, it becomes apparent with the viewing of aerials with much of the stream channel still appearing to be relatively exposed. Most of the vegetation present along the creek through this broad floodplain area is relatively shrubby vegetation such as and including willows. As such, the channel is partly exposed to direct sunlight, which tends to allow for temperature increases. The remedy for this condition is in place with the existing, immature vegetation, and shade cover should increase substantially over the next decade.
Water quality improvement	HIGH: Broad floodplain buffer areas across most of this unit are vegetated with shrubs, grasses, emergent vegetation, and some trees. These combine to provide a fairly effective level of biofiltration for both overbank flood flows and water moving to the creek locally through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: The well-vegetated streambanks through this area, coupled with lower gradients, result in relatively stable banks and limit the rate of channel migration and associated erosion. However, channel migration may occur due to the low gradients and resulting deposition in the existing channel, though this is not necessarily detrimental.
Attenuating flow energy	HIGH: The dense, shrubby vegetation across broad, active floodplain areas as well as along the streambanks results in high levels of energy attenuation during high flows. Placed in-stream wood is of fairly large size and some has been placed in the form of jams. These LWD features tend to further attenuate energy, forming pool and riffle features in the process.
Sediment removal	HIGH: As stated above, the presence of a wide floodplain throughout this unit coupled with a lower channel gradient allows buffer vegetation to filter fine sediments from flood flows as they spread out of the channel and across the floodplain. This buffer vegetation is also able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, well-vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the primarily willow trees along other bank sections and throughout the buffer are shrubby, fairly small deciduous trees with a fairly short functional lifespan when and if they do fall into the stream.
Hyporheic	
Removing excess nutrients and toxic compounds	MODERATE/HIGH: The low streambanks and broad floodplain areas throughout this unit contribute to an extensive hyporheic zone. Soils may be finer than ideal for most hyporheic functions; however, the broad area available tends to make up for this. (As stated above, biofiltration function at the surface is also expected to be high.)
Water storage and	MODERATE/HIGH: As above, though the permeability of hyporheic

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
maintenance of base flows	soils may not be particularly high, the area of hyporheic flow is extensive. Coarser soils have more space available between their particle grains for the storage of both water and sediment.
Support of vegetation	HIGH: Low streambanks and wide floodplains through portions of the area appear to allow vegetation over broad areas to be watered from hyporheic sources.
Sediment storage	MODERATE: As above, the permeability of the relatively fine-grained hyporheic soils across this unit is not expected to be high, limiting the potential for sediment storage even though the area available is fairly large. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Non-hyporheic sediment storage can also occur due deposition at the surface, however.
Habitat	
Physical space and conditions for life history	<p>MODERATE/HIGH: The broad, partially wetland floodplain areas across this unit provide a diverse assemblage of habitat types for a variety of wildlife species including songbirds, waterfowl, rodents, beavers, and others. Though habitat in and along North Creek through this unit has still been reduced somewhat in quality, quantity, and complexity compared to its original condition, it has changed markedly from the times of its agricultural use, and restoration activities have put it on track for a nearly full recovery over time. Maturing trees will provide an increasing number of nesting sites, including hollows, and will eventually recruit LWD to the channel, though much of this wood will be short-lived deciduous. Impaired water quality and quantity inputs from upstream may slow recovery progress and limit potential, however.</p> <p>Within the channel, placed and constructed log jams and other structures have similarly resulted in a good start to recovery, helping to form pool and riffle sequencing and providing cover. LWD recruitment going forward will be important to replace this placed wood as it reaches its useful lifespan.</p>
Food production and delivery	MODERATE/HIGH: Food production from riparian and upland areas originates largely from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are typically broad and well-vegetated across this unit, the vegetative community still lacks in maturity and diversity compared to its original condition, though this will improve over time.
Summary	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Campus assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.

4.3.7 Swamp Creek – City of Bothell and City of Brier

The Swamp Creek – City of Bothell and City of Brier assessment units (Reaches 7a/b and 8) consist of the entire Swamp Creek shoreline jurisdiction in both cities (Exhibits 10a & b and 11). These assessment units are grouped in this function analysis because there are no significant differences in ecological function. The assessment units include a total of approximately 2.37 and 0.12 miles of shoreline, respectively, and 109.22 and 5.01 acres, respectively, of total jurisdiction. An additional 39.01 acres of potentially associated wetlands extend into Brier city limits and expansion areas and the City of Bothell upstream of the 20 cfs limit of Swamp Creek and along Locust Creek.

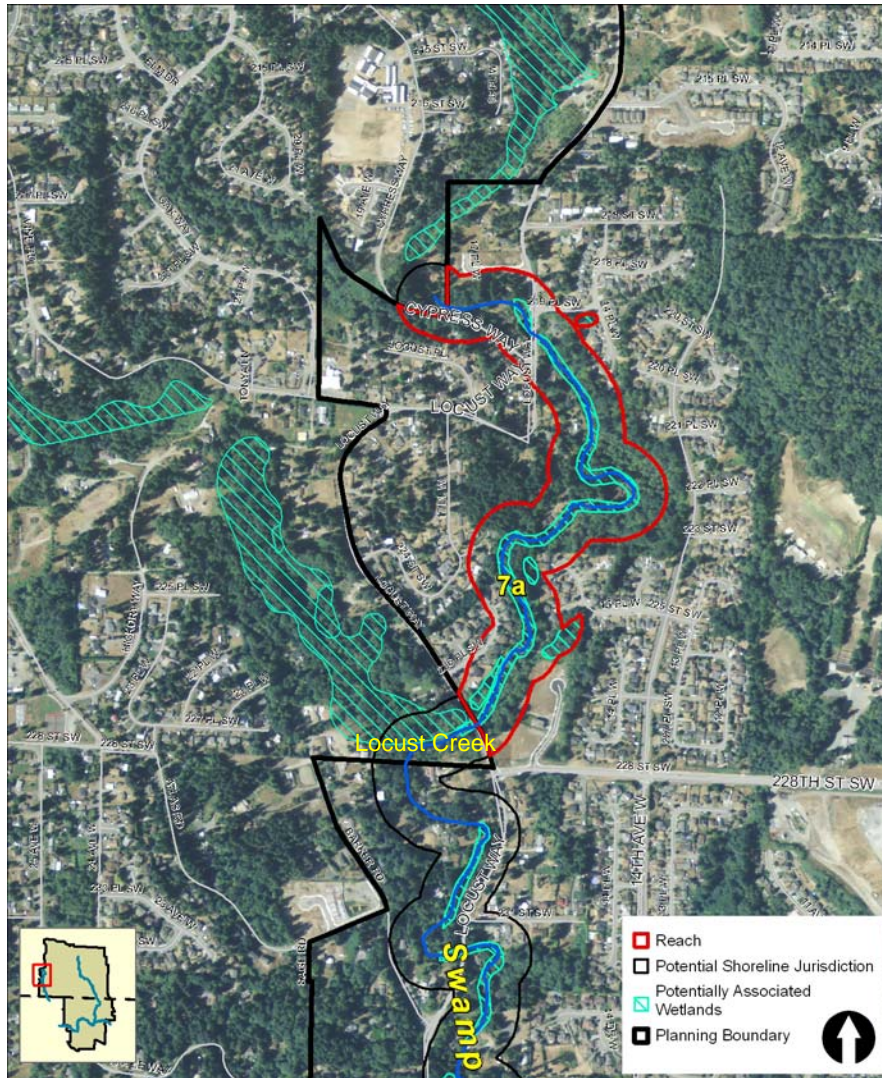


Exhibit 10a. Aerial photo of North Creek - City of Bothell assessment unit north of 228th Street SW (Reach 7a)

Swamp Creek in the City of Bothell (Unit 7) is listed as impaired for dissolved oxygen based on sampling from 2004-2006 (Ecology, electronic reference). Fecal coliform impairment has also been documented in this unit, and it is included by the Swamp Creek fecal coliform TMDL (Ecology 2006). Unit 7 is also listed as a water of concern for temperature based on temperature measurements in 2001 (Ecology, electronic reference). Although Swamp Creek water quality impairments have not been explicitly identified in the City of Brier, water quality conditions are likely similar to the adjacent downstream unit, so concerns about dissolved oxygen, fecal coliform, and temperature should be addressed in this reach as well.

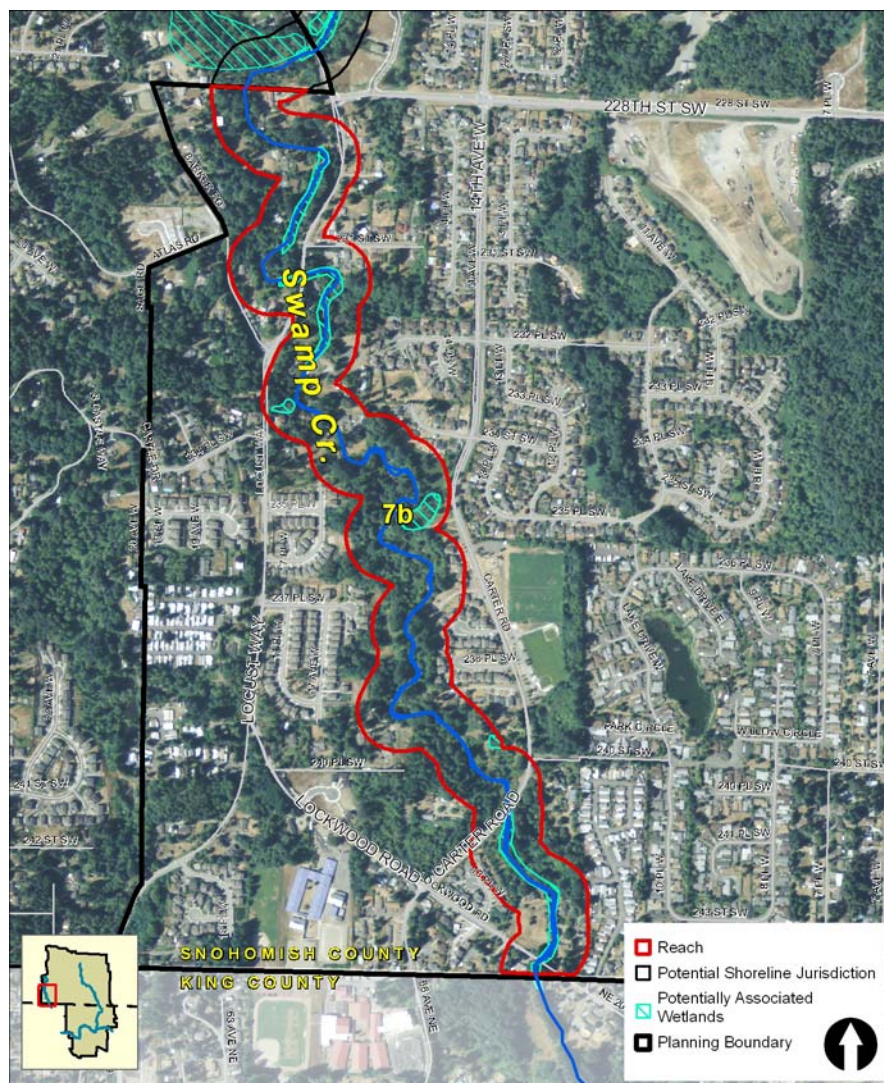


Exhibit 10b. Aerial photo of North Creek - City of Bothell assessment unit south of 228th Street SW (Reach 7b)

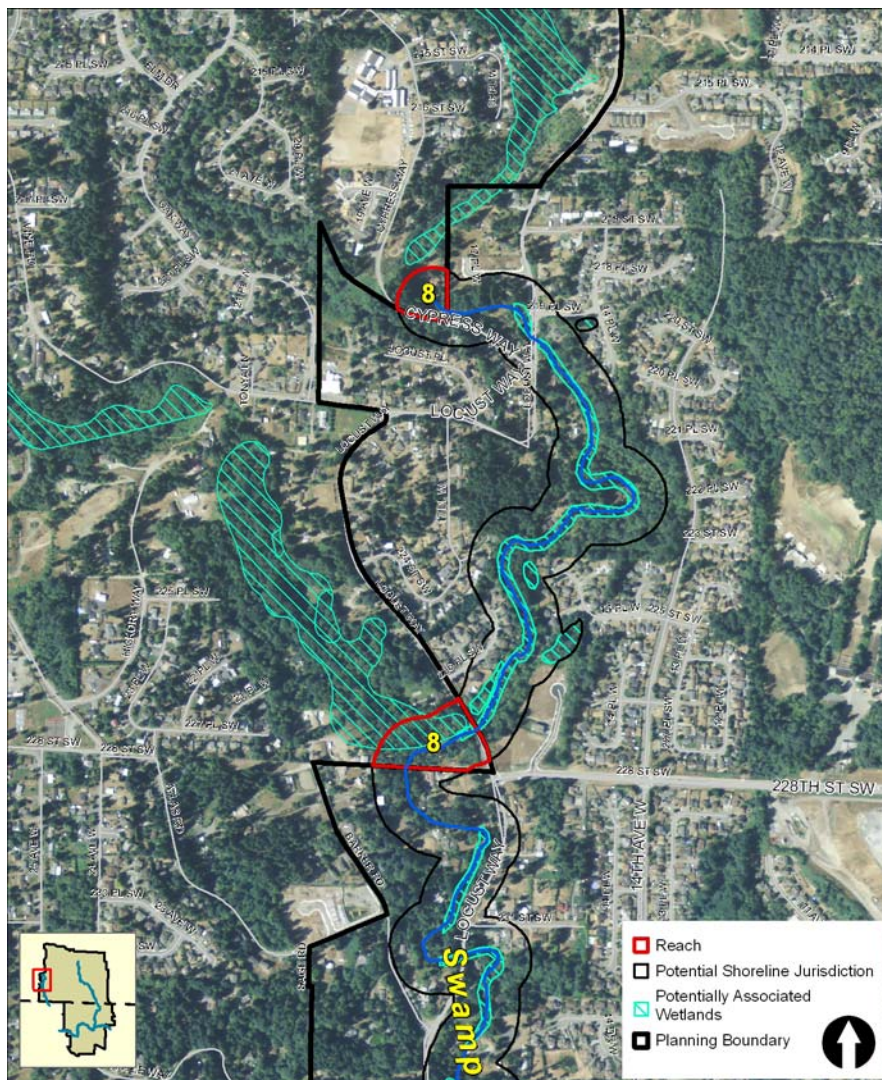


Exhibit 11. Aerial photo of Swamp Creek - City of Brier assessment unit (Reach 8)

Table 14. Function Summary of Swamp Creek – City of Bothell and City of Brier (Reaches 7 and 8).

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Hydrologic	
Storing water and sediment	LOW/MODERATE: Within Reaches 7 and 8, Swamp Creek flows through a residential area with quite variable effective buffer widths and degree of vegetation. While streambanks are not particularly high, the actual floodplain is fairly narrow (Figure 13A, page C-28 and Figure 10, page D-10). Out-of-channel flows do not tend to flood adjacent residential properties, being confined to the fairly narrow floodplain/buffer areas. Basin-wide, Swamp Creek is true to its name in that its basin includes several extensive riparian wetland floodplain

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	areas which are effective at storing both water and sediment. One of these areas occurs just north of the I-5/I-405 interchange. However, these do not occur within the Bothell and Brier shoreline jurisdiction assessment units, and the floodplain storage function for both water and sediment in these units is relatively low.
Transport of water and sediment	MODERATE/HIGH: The single-thread stream corridor has a moderate gradient and, though it has moderate bank vegetation and moderate channel roughness, it appears to lack any major obstruction and so is fairly efficient at transporting both water and sediment.
Attenuating flow energy	MODERATE: Portions of this section of Swamp Creek are lined with young forest and shrubby vegetation dominated by young alder (Figure 16A, page C-34 and Figure 13, page D-13). As such, channel roughness is moderately high and well-distributed where such vegetation and in-channel wood derived from it is present, providing energy attenuation during high flows.
Developing pools, riffles, and gravel bars	MODERATE: This section of Swamp Creek includes predominantly moderate-sized, but short-lived pieces of wood derived from the predominantly young forest it flows through. Much of the wood recruited is short-lived deciduous, such as and including alder. Sinuosity is moderate. These conditions are conducive to the formation of pools of moderate depth and complexity, with intervening riffles, and the formation of some gravelly bars on the inside of channel bends. The reach is relatively evenly balanced between riffles and pools, with riffles composing approximately 40% of the total reach length (Fevold et al. 2001)
Removing excess nutrients and toxic compounds	MODERATE: The lack of a broad floodplain along this unit results in incomplete biofiltration functions and, high levels of fecal coliform bacteria and low levels of dissolved oxygen indicate that the loading of nutrients and other pollutants is high in this unit. The presence of some densely-vegetated buffer areas and relatively stable vegetated banks helps to filter nutrients and toxic compounds.
Recruitment of LWD and other organic matter	MODERATE (LOW/MODERATE for LWD, MODERATE/HIGH for other organic matter): Unevenly-vegetated buffers through this reach and extending farther upstream contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, trees along the banks and throughout the buffer are generally immature deciduous trees with a fairly short functional lifespan when and if they do fall into the stream. Fevold et al. (2001) found that the frequency of large wood in this unit was low, at 39 pieces per km.
Vegetation	
Temperature regulation	MODERATE: The existing banks and buffers are vegetated with dense, shrubby vegetation along much of the channel length through this unit and therefore provide a good amount of shading to the creek where present; a moderate level overall. Good shading conditions tend to decrease temperature and allow for increased dissolved oxygen.
Water quality improvement	MODERATE: While buffer vegetation is fairly dense in places, it is not dense in others. Relatively narrow floodplain areas also tend to limit the biofiltration of flood flows. Buffer areas that are vegetated with trees, shrubs, grasses, emergent vegetation, and other riparian

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	vegetation offer a fairly effective level of biofiltration for water moving to the creek through the buffers.
Slowing riverbank erosion; bank stabilization	MODERATE/HIGH: With exceptions, the generally well-vegetated streambanks through this area result in relatively stable banks and limit the rate of channel migration and associated erosion.
Attenuating flow energy	MODERATE: The presence of fairly dense adjacent streambank and riparian vegetation contributes to energy attenuation during high flows. However, in-stream wood is of only moderate size and is short-lived.
Sediment removal	MODERATE: As stated above, the lack of a wide floodplain limits the ability of the buffer vegetation that is present to filter fine sediments from flood flows already in the channel. However, this buffer vegetation is able to remove sediment from locally-generated flows moving towards the creek.
Provision of LWD and other organic matter	MODERATE: As stated above, unevenly vegetated buffers through this reach contribute to the recruitment of leaf litter and other small organic material in support of a detrital-based food chain. However, the immature trees along the banks and throughout the buffer are typically fairly small deciduous trees, including alder, with a fairly short functional lifespan when and if they do fall into the stream.
Hyporheic	
Removing excess nutrients and toxic compounds	LOW/MODERATE: Although the somewhat meandering nature of the channel and moderate bank height indicate the presence of a functional hyporheic zone with alluvial, somewhat pervious soils, the width of the zone is fairly limited. The natural potential for hyporheic removal of excess nutrients and toxic compounds is not expected to be high based on this limited width.
Water storage and maintenance of base flows	LOW/MODERATE: As above, the width of the zone of hyporheic flow is fairly narrow, limiting the potential for water storage and associated base-flow maintenance.
Support of vegetation	MODERATE: Streambanks through the area appear to be low enough along much of the length to allow vegetation to be watered from hyporheic sources.
Sediment storage	LOW/MODERATE: The narrow width of the hyporheic zone and the fluctuating, urban nature of Swamp Creek flows tend to limit the amount of sediment that can be captured and stored in the hyporheic zone along the reach.
Habitat	
Physical space and conditions for life history	MODERATE: Though the buffer area is of moderate width and is fairly well-vegetated and functional in places, habitat in and along Swamp Creek through this unit has been reduced in quality, quantity, and complexity compared to its original condition. The vegetative community has been reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. This reduction in dense, but also in diverse, riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	Within the channel, fewer log jams and less wood and less persistent wood overall similarly result in less available protective cover, and diminishes the creation of pool/riffle sequences as well.
Food production and delivery	MODERATE: Food production from riparian and upland areas originates largely from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life. Though streamside areas are well-vegetated in places, overall diversity, complexity, and maturity are diminished, thereby detracting from this unit's value as wildlife habitat.
Summary	The ecological conditions in the Swamp Creek- City of Bothell and City of Brier assessment units are essentially identical. Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Swamp Creek – City of Bothell and City of Brier assessment units, the overall shoreline ecological function is considered MODERATE.

4.3.8 Sammamish River – Reaches 9 through 14

The following reaches are merged in the function summary table below:

9. Sammamish River – Woodinville Drive (from east city limits to mobile home park) (Exhibit 12)
10. Sammamish River – Brackett's Landing (from Valley View mobile home park to Sammamish River Trail bridge crossing) (Exhibit 12)
11. Sammamish River – Sammamish River Park (Exhibit 13)
12. Sammamish River – Downtown (from SRT bridge to Park at Bothell Landing bridge - north bank only) (Exhibit 13)
13. Sammamish River – Bothell Way Corridor (from Bothell Landing Bridge to 96th Avenue NE - north bank only) (Exhibit 13)
14. Sammamish River – Wayne Golf Course (both banks west of 96th Avenue NE) (Exhibit 13)

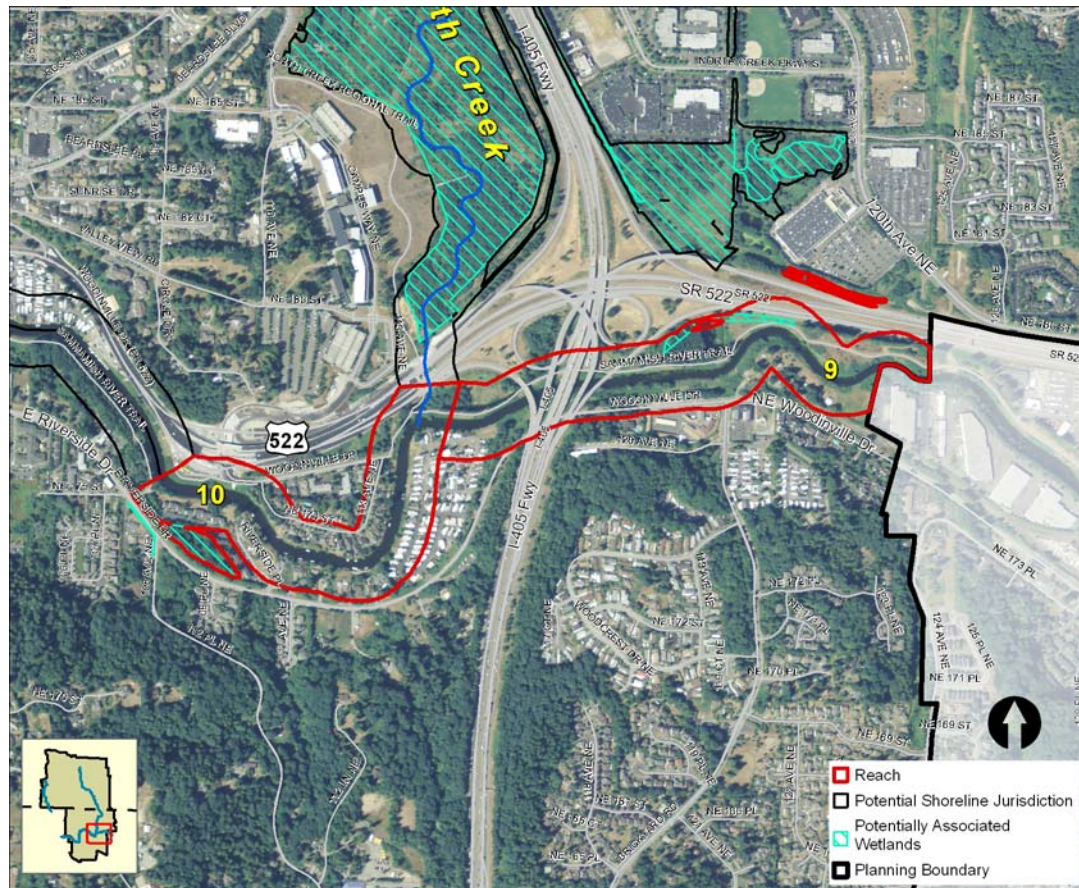


Exhibit 12. Aerial photo of Sammamish River – Reach 9 (Woodinville Drive) and Reach 10 (Brackett's Landing)

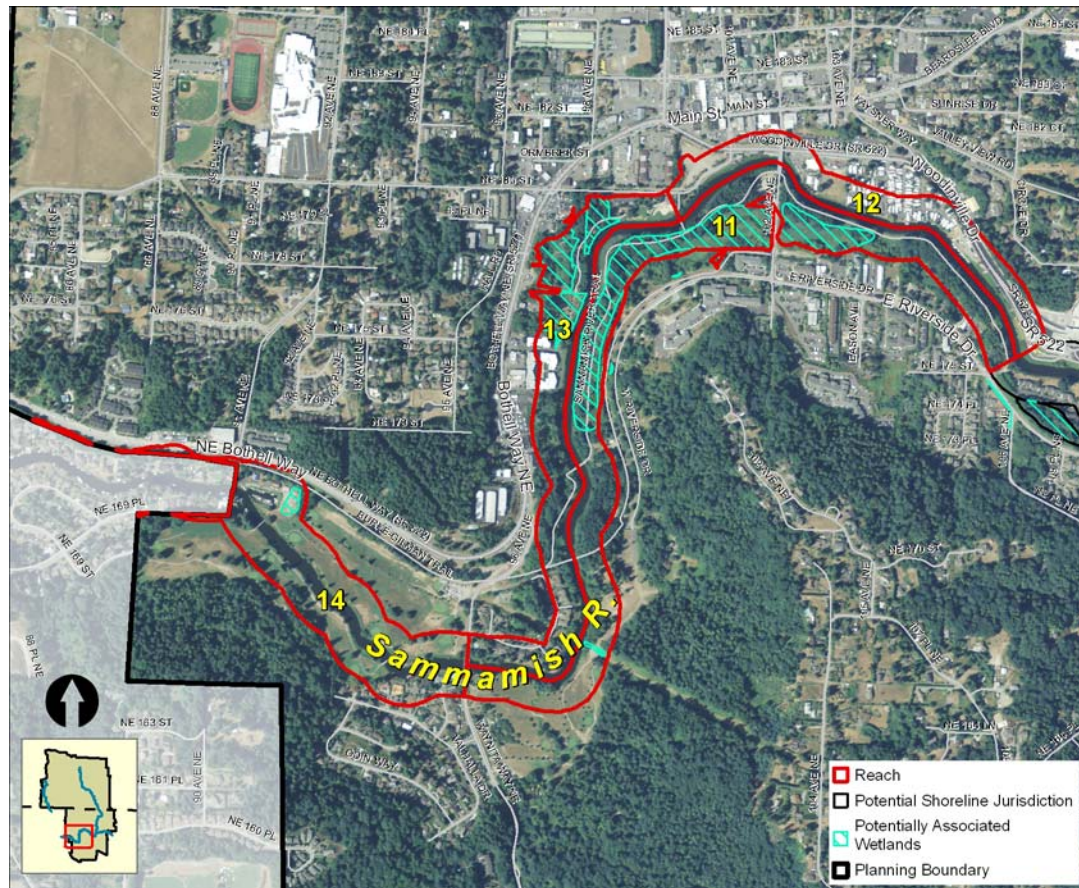


Exhibit 13. Aerial photo of Sammamish River – Reach 11 (Sammamish River Park), Reach 12 (Downtown), Reach 13 (Bothell Way Corridor), and Reach 14 (Wayne Golf Course)

Because of past alteration and management of the Sammamish River as it passes through the City of Bothell, instream conditions and ecological functions are essentially identical. In any reach where the condition and function is unique from the other reaches, that is described within the appropriate subject row of the table. The total shoreline jurisdiction area of Reaches 9 through 14 is 174.55 acres, along 5.18 miles of the Sammamish River (Exhibits 12 & 13).

The flow rate and, particularly, the river elevation or level of the Sammamish River through Bothell, is controlled significantly by artificial means – the weir at Lake Sammamish and the Locks, respectively. The locks do not affect flow, but control the level by backwatering from Lake Washington and tend to create high water in the summer and maintain low water in the winter, which is the opposite of a natural system.

Reaches 9-12 are on the state's 303(d) list of impaired waters for dissolved oxygen and fecal coliform because sampling from 2004 through 2006 found that water consistently did not meet standards (Ecology, electronic reference).

Hallock (2001 cited by Ecology, electronic reference) found similar results in water quality sampling in 1993 and 1994.

Table 15. Function Summary of the Sammamish River – Reaches 9 through 14.

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Hydrologic	
Storing water and sediment	<p>LOW: Within the study area, the river flows through and is constrained by a constructed (dredged) channel cross section. The river is prevented from migrating or meandering, and is cut off from and/or excavated below its historic floodplain and/or former channel where either or both of these still exist (Figure 9B, page C-21). Though a formal system of flood control levees does not appear to have been constructed, berms formed as a result of dredge spoil placement tend to disconnect and otherwise reduce interaction between the river and its floodplain, including remnants of the old channel (Figure 13B, page C-29). There is virtually no space available within the constructed cross section to allow for any meaningful storage of water or sediment while still allowing sufficient conveyance capacity for the flood protection of infrastructure and other property. The narrow, deepened channel prevents fine sediments from reaching all portions of floodplain topsoil to nourish vegetative growth, in turn supporting wildlife habitat.</p>
Transport of water and sediment	<p>LOW/MODERATE: Though the channel form was created by dredging specifically for the purpose of improving flow conveyance, the very low channel gradient and associated low-energy nature of the system limit its ability to move both water and sediment. However the needs for water and sediment transport are moderated, because Lake Sammamish provides a high level of natural detention storage to attenuate river flow fluctuations as well as providing an essentially sediment-free source of flow. Sediment supply to the river comes primarily from its various tributaries including Bear Creek, Little Bear Creek, North Creek, and Swamp Creek. Deposition tends to occur near the mouths of these creeks.</p>
Attenuating flow energy	<p>LOW/MODERATE: The Sammamish River channel is generally simple and smooth with few features such as LWD or dense vegetation along its banks to provide roughness and dissipate energy. However, within portions of the Sammamish River Park (Reach 11), there is quite a large growth of black cottonwood and Oregon ash trees which have, on occasion, fallen into the river. Also, the northern portion of Reach 13 has received large amounts of re-vegetation with deciduous trees and shrubs. However, the channel is very low gradient and so there is very little energy to diffuse. Attenuating what little flow energy there is could interfere with the channel's ability to pass flow.</p>
Developing pools, riffles, and gravel bars	<p>LOW: By design, the Sammamish River tends to consist predominantly of runs (which are lengths of relatively deep but still-moving water) along its entire length from Lake Sammamish to Lake Washington. In order to provide adequate conditions for salmon migration, pool habitats, with greater than 1.5 ft residual depth, should cover 40-60% of the total length of the river (Raleigh et al. 1986 cited in Tetra Tech 2002).</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	<p>The river is generally lacking in large woody debris within the channel and is maintained as such to provide adequate conveyance capacity. Though volunteers have planted numerous trees as part of the Bothell – Woodinville – Redmond Re-Leaf projects in both Reach 11 and the northern portion of Reach 13, these plantings have not yet translated to in-channel wood, nor is it clear if they will be allowed to do so given maintenance activities described previously which are intended to keep the channel largely clear of such wood. As mentioned above, source flow from Lake Sammamish is virtually sediment-free and so gravel to form bars is only available from the tributaries. Limited bars have formed at the mouths of these tributaries, such as at the mouths of North and Swamp Creeks. Another gravel bar, similarly supplied by a tributary located on the golf course, somewhat restricts the river in front of the 'back' nine of Wayne Gold Course, east of 96th Avenue. Energy and obstructions such as log jams are generally not sufficient to scour pools or form intervening riffles, hence the predominance of runs. Combined with the fine-grained texture of the bank soils and substrate, the development of pools, riffles, and gravel bars is very limited.</p>
Removing excess nutrients and toxic compounds	<p>LOW: The much reduced extent and function of a once-extensive floodplain, especially along Reach 9, results in very limited biofiltration function. The remaining limited function now occurs only within the channel itself. Developed upland shoreline areas are a source of nutrients, bacteria (fecal coliform), and toxic compounds from landscaping runoff (pesticides, fertilizers, herbicides) and road runoff (hydrocarbons, metals).</p>
Recruitment of LWD and other organic matter	<p>LOW (Reaches 9, 10, and 12-14): Little or no channel migration tends to occur, which would recruit any trees in the channel's path as LWD. Furthermore, riverbank vegetation other than grasses and low, sometimes non-native shrubs is generally sparse, precluding significant recruitment of large logs and reducing inputs of small woody debris as well.</p> <p>LOW/MODERATE (Reach 11): Some leaf litter and other small vegetative materials are recruited where trees overhang the banks, such as along Reach 11, Sammamish River Park. A few trees have also fallen into the river in the past few years. Some of these trees have remained where they fell, but others have been removed.</p>
Vegetation	
Temperature regulation	<p>LOW (Reaches 9, 10, and 12-14): The Sammamish River is largely lacking in riparian vegetation. Since riverbank vegetation other than grasses and low shrubs is sparse except for some select areas within these reaches, the river channel goes largely unshaded. A more continuous riparian buffer is a critical step to addressing high water temperatures in the Sammamish River. Also contributing to high temperatures in the river are reduced summer low flow conditions (Tetra tech 2002) and the fact that flows in the river are derived predominantly from the surface waters of Lake Sammamish, which stratifies during the summer with surface waters much warmer than at depth.</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	LOW/MODERATE (Reaches 11 and 13): Better shade is provided by trees on the south side of the river in Sammamish River Park and along Bothell Landing Park. In fact, these reaches may have the most riparian vegetation of all the reaches along the entire Sammamish River.
Water quality improvement	<p>LOW (Reaches 9, 10, and 12-14): Wide floodplain areas that are densely vegetated with trees, shrubs, grasses, emergent vegetation, and other riparian vegetation offer an effective level of biofiltration. Historically, the Sammamish River had such a floodplain, but it has been largely eliminated due to the lowering of Lake Washington and Corps dredging and armoring along the length of the river. Not only does the water within the river channel go largely unfiltered, but water quality contaminants such as fertilizers, herbicides, pesticides, hydrocarbons, metals, and eroded soils (from developed upland areas and roadways) can now more easily reach the river via distinct drainage pathways which cut across the former floodplain. Vegetation along these reaches presently offers little potential to improve fecal coliform and dissolved oxygen impairments in these reaches of the Sammamish River.</p> <p>LOW/MODERATE (Reach 11): Improved biofiltration is provided by mixed vegetation lining the river in Sammamish River Park.</p>
Slowing riverbank erosion; bank stabilization	MODERATE: River flow energy is quite low so, while existing riverbank vegetation consists primarily of grasses and low shrubs, this existing vegetation appears relatively effective at stabilizing soils and slowing the rate of bank erosion.
Attenuating flow energy	LOW/MODERATE: As stated above, the Sammamish River channel generally lacks dense vegetation along its banks to provide roughness and dissipate energy. However, the channel is very low gradient and so there is very little energy to diffuse. Attenuating what little flow energy there is could interfere with the channel's ability to pass flow.
Sediment removal	LOW/MODERATE: The lack of an effective floodplain results in the inability to effectively filter fine sediments. However only the tributaries are potential sources of significant levels of sediment given the predominance of source flow from Lake Sammamish.
Provision of LWD and other organic matter	<p>LOW (Reaches 9, 10, and 12-14): As stated previously, riverbank vegetation other than grasses and low shrubs is sparse, precluding significant recruitment of large logs and other vegetative materials.</p> <p>LOW/MODERATE (Reach 11): Some leaf litter and other small vegetative materials are recruited where trees overhang the banks, most notably along Reach 11, Sammamish River Park.</p>
Hyporheic	
Removing excess nutrients and toxic compounds	LOW: The river has been isolated from its floodplain, and similarly its hyporheic zone, primarily due to channel lowering by dredging. Furthermore, soils along the river are largely fine-grained and not as conducive to hyporheic flow as a coarser substrate would be, limiting the natural potential for hyporheic removal of excess nutrients and

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	toxic compounds.
Water storage and maintenance of base flows	LOW: As described above, the hyporheic zone has been partially drained through channel lowering by dredging and existing soils are not likely conducive to significant hyporheic flow, both limiting the potential for water storage and base-flow maintenance.
Support of vegetation	<p>LOW (Reaches 9-13): Especially during the summer, the river is well below its banks. The vegetation supported by hyporheic flow would likely extend only a short distance up the steep banks.</p> <p>MODERATE (Reach 14): Banks are lower along the Wayne Golf Course (Reach 14), however, including the lower reaches and mouth of Tributary 0066, with its broad, grassy floodplain-like area. With these low banks, less impervious surface, and lack of a storm drainage and roadway grid that would be associated with urban or suburban development, this area likely has increased hyporheic activity compared with adjacent reaches.</p>
Sediment storage	LOW: As described above, the river has been isolated from its floodplain, and similarly its hyporheic zone, primarily due to channel lowering by dredging. In addition, soils along the river are largely fine-grained and not as conducive to hyporheic flow as a coarser substrate would be, limiting the natural potential for hyporheic fine-grained sediment removal and storage.
Habitat	
Physical space and conditions for life history	<p>LOW/MODERATE (Reaches 9, 10, and 12-14): Habitat in and along the Sammamish River has been reduced in quality, quantity, and complexity compared to its original condition (prior to channelization in 1964 and its use as a navigable waterbody). The vegetative community has been much reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. The reduction of dense riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.</p> <p>Within the channel itself, far fewer log jams, much less wood overall, and a simple, single-thread channel form similarly result in less available habitat with less protective cover as well.</p> <p>The river also has 1.06 acres of overwater structures, distributed in each reach. The most overwater cover (0.5 acre) is present in Reach 9 (I-405/SR 522 overpass), which has sufficient height above the water to preclude major impacts. The largest overwater cover close to the water's surface is provided by the Blue Heron Marina, totaling approximately 0.1 acre in a small embayment in Reach 14. Most of the other overwater structures are small bridges and a few piers. There is a pretty wide scattering of individual docks along the residential areas.</p> <p>MODERATE (Reach 11): Somewhat more abundant vegetation along this reach provides additional upland habitat function compared to the other reaches.</p>

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Food production and delivery	<p>LOW/MODERATE (Reaches 9, 10, and 12-14): Food production from upland areas originates from native seed- and fruit-bearing vegetation. Not only does such vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drops into the water and provide food, either directly or indirectly, for fish and other aquatic life.</p> <p>MODERATE (Reach 11): Again, somewhat more abundant vegetation along this reach provides additional upland habitat function with respect to food production compared to the other reaches.</p>
Summary	<p>Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River, the overall shoreline ecological function for each reach is listed below:</p> <p>Woodinville Drive - Reach 9: LOW/MODERATE Brackett's Landing – Reach 10: LOW/MODERATE Sammamish River Park – Reach 11: MODERATE Downtown – Reach 12: LOW/MODERATE Bothell Way Corridor – Reach 13: LOW/MODERATE Wayne Golf Course – Reach 14: MODERATE</p>

4.3.9 Sammamish River – Bothell Business Park Floodway

The Sammamish River – Business Park Floodway assessment unit (Reach 15) consists of those areas of Sammamish River floodplain/floodway located north of State Route 522 and east of Interstate-405 (Exhibit 14). The assessment unit includes approximately 22.88 acres of total jurisdiction.

No water quality impairments have been measured and reported in this unit (Ecology, electronic reference), however, that may be attributable to a lack of sampling stations in this unit, and some impairment is likely given sampling results in units upstream.

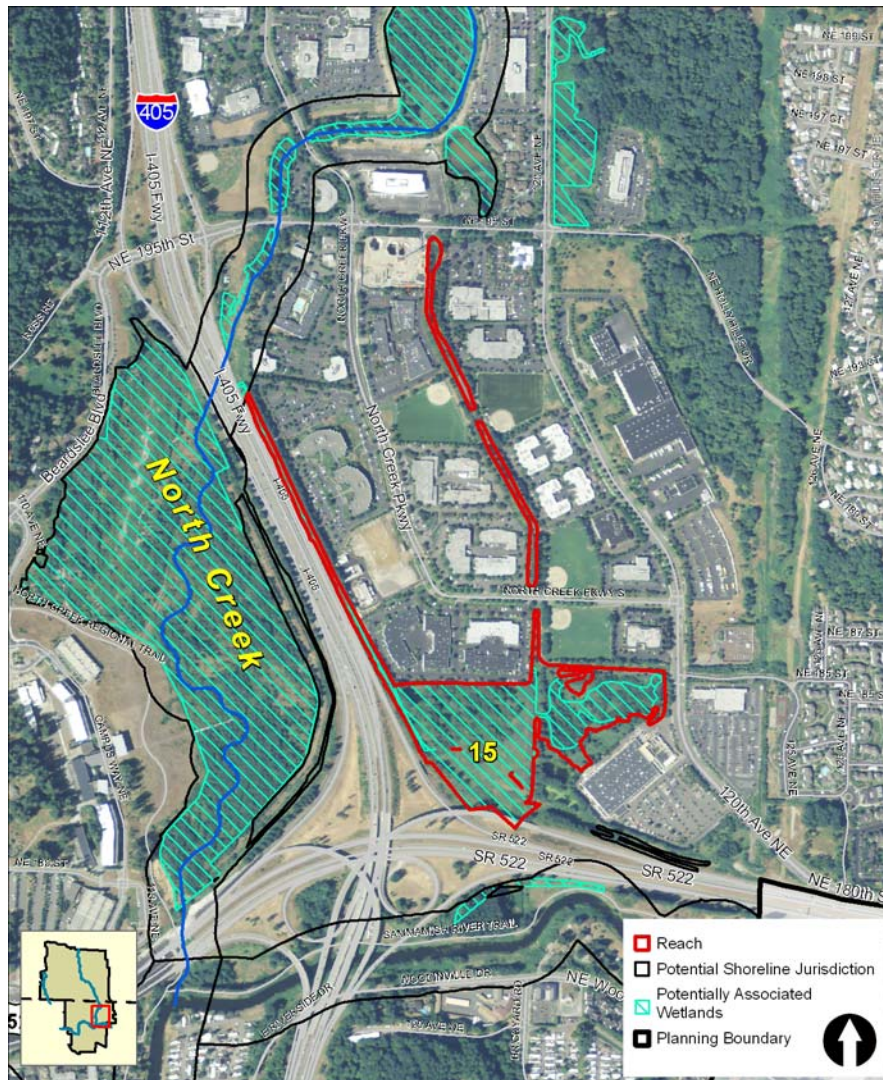


Exhibit 14. Aerial photo of Sammamish River – Reach 15 (Bothell Business Park Floodway)

Table 16. Function Summary of Sammamish River – Bothell Business Park Floodway (Reach 15)

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
Hydrologic Storing water and sediment	LOW: These floodplain areas would be moderately effective at storing water and sediment, but only when activated during extreme flood events. These floodplain areas are separated from the Sammamish River by SR 522. Exchange of water between the river and floodplain is restricted/constricted by various culvert crossings, both upstream and downstream, which would inhibit the free exchange of water and sediment. These constrictions may prevent fine sediments from

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
	reaching all portions of floodplain topsoil to nourish vegetative growth, in turn supporting wildlife habitat.
Transport of water and sediment	LOW: These are floodplain areas that function primarily to store water and sediment rather than transport them except as they drain out as flood levels drop.
Attenuating flow energy	LOW: These are low-energy, floodplain storage areas that would have little energy-attenuating function.
Developing pools, riffles, and gravel bars	LOW/NA: These floodplain areas do not include a shoreline channel, so these processes are not applicable.
Removing excess nutrients and toxic compounds	LOW/MODERATE: These floodplain areas would be effective at biofiltering out nutrients and toxic compounds, but only when activated during extreme flood events.
Recruitment of LWD and other organic matter	LOW: Tree size and abundance is limited on these floodplain areas and it is doubtful that any LWD from these areas would pass through culverts to be recruited to the river. Some smaller organic materials such as and including leaf litter could be supplied to the river.
Vegetation	
Temperature regulation	LOW: There is little water present in these floodplain areas to shade most of the time. Some vegetative shading could be provided to the drainage (Parr Creek) which passes through the area, but these floodplain areas are not well-forested overall and flooding typically occurs during the late fall and winter when temperature is not of concern.
Water quality improvement	LOW/MODERATE: As stated above, these floodplain areas would be effective at biofiltering out nutrients and toxic compounds, but only when activated during extreme flood events. They are primarily vegetated with fine-textured grasses, emergents, and low shrubs which are particularly effective at biofiltration.
Slowing riverbank erosion; bank stabilization	LOW/NA: These floodplain areas do not include a shoreline channel, so these processes and functions are not applicable.
Attenuating flow energy	LOW: Again, these are low-energy, floodplain storage areas that would have little energy-attenuating function.
Sediment removal	LOW/MODERATE: These floodplain areas would be effective at biofiltering out fine sediments, but only when activated during extreme flood events.
Provision of LWD and other organic matter	LOW: Some leaf litter and other small organics could be supplied to the river as a result of storm events. Few trees are present in these areas to supply LWD, and it is also doubtful that LWD would be supplied to the river by intervening culverts.
Hyporheic	
Removing excess nutrients and toxic compounds	LOW: The river has been isolated from its floodplain, and similarly its hyporheic zone, primarily due to channel lowering by dredging. These floodplain areas are also located at some distance laterally from the river channel. Furthermore, soils along the river are largely fine-grained and not as conducive to hyporheic flow as a coarser substrate would be, limiting the natural potential for hyporheic removal of excess nutrients and toxic compounds.
Water storage and	LOW: As described above, the hyporheic zone has been partially

Shoreline Processes and Functions within Assessment Unit	Alterations and Assessment of Functions
maintenance of base flows	drained through channel lowering by dredging and existing soils are not likely conducive to significant hyporheic flow, both limiting the potential for water storage and base-flow maintenance.
Support of vegetation	MODERATE: Though hyporheic flow from the river is limited, drainages (including Parr Creek) pass through these floodplain areas and would tend to keep soil moisture fairly high across the floodplain during the growing season for use by plants. However, a network of drainages tends to reduce this plant-watering effect.
Sediment storage	LOW: Hyporheic flows associated with the river are expected to be low due to the dredged nature of the river channel and the distance of these floodplain areas from the river. Also, as above, the permeability of fine-grained hyporheic soils is not expected to be high, limiting the potential for sediment storage. Coarser soils have more space available between their particle grains for the storage of both water and sediment. Fine-grained hyporheic soils tend to limit the amount of sediment that can be captured and stored.
Habitat	
Physical space and conditions for life history	LOW/MODERATE: Habitat in and along the Sammamish River, including these remnant floodplain areas, has been reduced in quality, quantity, and complexity compared to its original condition (prior to lowering of the river channel through channelization). The vegetative community has been much reduced in scale, with less accumulated downed wood and snags, resulting in fewer places for various wildlife species to find cover or suitable nesting and rearing sites. The reduction of dense riparian vegetation is a limiting factor for terrestrial species' (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are more restricted.
Food production and delivery	MODERATE: Food production from upland areas originates from native seed- and fruit-bearing vegetation. Though immature, the vegetative community in these floodplain areas provides considerable diversity and complexity, including convoluted edges between meadow and tree/shrub areas.
Summary	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River – Bothell Business Park Floodway assessment unit, the overall shoreline ecological function is considered LOW.

4.4 Restoration Opportunities

The assessment of processes and functions for each assessment unit is followed in the table by identification of opportunities and recommendations for protecting existing functions and processes or restoring impaired functions and processes. Ecology's *Shoreline Master Program Guidelines* (173-26 WAC) includes the following definition:

“Restore,” “Restoration” or “ecological restoration” means the reestablishment or upgrading of impaired ecological shoreline processes

or functions. This may be accomplished through measures including but not limited to re-vegetation, removal of intrusive shoreline structures and removal or treatment of toxic materials. Restoration does not imply a requirement for returning the shoreline area to aboriginal or pre-European settlement conditions.

Consistent with Ecology's definition, use of the word "restore," or any variations, in this document is not intended to encompass only actions that re-establish historic conditions. Instead, it encompasses a suite of strategies that can be approximately delineated into four categories: creation (of a new resource), restoration (of a converted or substantially degraded resource), enhancement (of an existing degraded resource), and protection (of an existing high-quality resource).

There is a critical distinction between restoration and mitigation. Mitigation will require applicants whose shoreline proposals will have adverse impacts to complete actions to mitigate those impacts or provide compensation in other ways for losses of ecological function. Degraded wetland buffers are required to be restored under both Cities' Critical Areas Ordinances (CAO). The Cities can encourage applicants to implement restoration actions that will improve ecological functions relative to the applicant's pre-project condition. As stated in WAC 173-26-201(2)(c):

It is intended that local government, through the master program, along with other regulatory and nonregulatory programs, contribute to restoration by planning for and fostering restoration and that such restoration occur through a combination of public and private programs and actions. Local government should identify restoration opportunities through the shoreline inventory process and authorize, coordinate and facilitate appropriate publicly and privately initiated restoration projects within their master programs. The goal of this effort is master programs which include planning elements that, when implemented, serve to improve the overall condition of habitat and resources within the shoreline area of each city and county."

Opportunities and recommendations for "restoration" that have been identified in local and regional restoration plans, as well as by City staff, are included in Table 17 and shown on Figure 18 in Appendix C. The primary sources of recommended restoration activities come from the WRIA 8 Chinook Conservation Plan (WRIA 8 2005), the Sammamish River Corridor Action Plan (Tetra Tech 2002), and TMDL implementation plans. Projects prioritized for implementation by 2012 by WRIA 8 are included on the 2010 3-Year Work Plan, as noted in Table 17.

There are also general categories of restoration or protection actions or programs that are not specially included in the table below. For example, enhancement of riparian vegetation, protection of wetlands and remnant upland forested areas, reductions or modifications to shoreline hardening, minimization of in- and over-water structures, and improvements to fish passage would each increase one or more ecological parameters of the Cities' shoreline. The Cities or private property owners could implement these options voluntarily or, depending on specific project details, they could be required measures to mitigate adverse impacts of new shoreline projects. More information about potential volunteer efforts will be provided in the restoration plan, including a list of helpful resources for volunteers.

In addition to the site-specific project recommendations identified in Table 17, the WRIA 8 Chinook Conservation Plan also identifies several programs and land use management activities to promote Chinook salmon recovery (WRIA 8 2005). These programs and others will be further developed in the restoration plan of this Shoreline Master Program.

Table 17. Restoration opportunities by reach (Figures 18A & B, pages C-40 to C-42). SC=Swamp Creek, NC= North Creek, and SR= Sammamish River.

Bothell SMP ID #	Project Name	Source/ID #	On WRIA 8, 2010 3-Year Work Plan?	Project Description
Reach 1				
NC-13	Twin Creeks Project Expansion and easements	WRIA 8 Chinook Salmon Conservation Plan/N377, N380	No	Expand Twin Creeks Project: Expand existing restoration project upstream and downstream of existing area just upstream of 208 th (in UGA). Restore riparian vegetation, add large woody debris, enhance side channel habitat. N377 Pursue Conservation Easement on Property Adjacent to Twin Creeks Project: Acquire easement for future stream enhancement work on Asia First property adjacent to Twin Creek project.N380
NC-14	North Creek Enhancements at Clearwater School	WRIA 8 Chinook Salmon Conservation Plan/N378	Yes	Continue North Creek School (now called Clearwater School) Project: Work with school to do additional riparian restoration, large woody debris addition, and side channel enhancements on their property. This project has been

Bothell SMP ID #	Project Name	Source/ID #	On WRIA 8, 2010 3-Year Work Plan?	Project Description
				one of Snohomish county's top priorities in recent years. (N378)
Reach 2				
NC-11	Restoration of Royal Anne and Filbert Creeks	WRIA 8 Chinook Salmon Conservation Plan/N375	No	<p>Enhance Creek in Thrashers Corner Area: Enhance incised stream channel (Royal Anne Creek) within Thrashers Corner area (owned by the City of Bothell). Restore riparian vegetation, plant conifers and add large woody debris. Beaver on the site will be an issue for riparian restoration.</p> <p>At the Filbert Creek crossing of 208th Street SE, fluctuating flows have resulted in alternating flushing erosion and smothering deposition within a new box culvert. Net deposition has resulted in loss of channel definition below. Placing wood in this channel section will provide cover for fish while yet allowing some pool formation and for the majority of the bedload sediments to move on through.</p>
NC-12	Centennial Park (formerly Thrashers Corner Regional Park) Forested Wetland Protection	WRIA 8 Chinook Salmon Conservation Plan/N376	No	Protect Forested Wetland South of Maltby Road: Protect forested, 10.5 acre wetland south of Maltby Road, including Filbert Creek.
Reach 3				
NC-9	North Creek Floodplain Restoration North of 228 th	WRIA 8 Chinook Salmon Conservation Plan/N373	No	Floodplain Restoration North of 228th: Acquire 16 acre property North of 228th, return creek to natural channel by removing berm that redirected it. Restore riparian vegetation and side channels, add large woody debris. Increase flood storage and flood refuge habitat.
NC-15	Perry Creek Flooding and Habitat	City Staff	No	In the area of 20 th Ave SE just north of 228 th , area is periodically flooded. Property

Bothell SMP ID #	Project Name	Source/ID #	On WRIA 8, 2010 3-Year Work Plan?	Project Description
				damage has occurred repeatedly to at least one home. The issue may have more to do with North Creek's flood height profile that backs up Perry Creek.
Reach 4				
NC-8	North Creek Forest Protection 3	WRIA 8 Chinook Salmon Conservation Plan/N372	No	Protect Forested Property North of 240 th : Protect forested, undeveloped property North of 240 th through conservation easement or acquisition. Reach has highest spawning area on North Creek. Last undeveloped portion of North Creek within City of Bothell. Potential upzoning being considered.
NC-10	Lower Palm Creek Restoration	WRIA 8 Chinook Salmon Conservation Plan/N374	No	Enhance Mouth of Palm Creek: Enhance mouth and lower 100 yards of Palm Creek as cold water refuge for juvenile Chinook. Barriers for coho have been identified in Palm Creek by the Adopt-a-Stream Foundation.
NC-5	Restore Riparian Wetland South of North Creek Parkway N	WRIA 8 Chinook Salmon Conservation Plan/N369	No	Restore Riparian Wetland South of North Creek Parkway N: Increase flood storage, setback levee, add large woody debris, remove invasive plant species and plant native vegetation. Likely to be FEMA issues with project due to high peak floods in reach. Past project done on site to breach levee - may need maintenance. 11 acre site within Bothell Business Park
Reach 5				
NC-3	North Creek Floodplain Restoration north of 195th	WRIA 8 Chinook Salmon Conservation Plan/N367	No	Potential floodplain restoration on unused baseball diamond north of 195th and privately owned property between 195th and I- 405. Setback levee, increase flood storage, restore off-channel habitat and add large woody debris.
NC-4	North Creek Riparian Wetland Restoration	WRIA 8 Chinook Salmon Conservation Plan/N368	No	Restore Riparian Wetland North of 195th: Add large woody debris, and remove invasive plant species and

Bothell SMP ID #	Project Name	Source/ID #	On WRIA 8, 2010 3-Year Work Plan?	Project Description
	North of 195th.			plant native vegetation. Site experiences high peak flows, well connected with North Creek. Property is 1.46 acres and is in Bothell Business Park.
NC-6	North Creek Forest Protection 1	WRIA 8 Chinook Salmon Conservation Plan/N370	No	Protect Forested Property to East of Reach 2: Protect forested, steep sloped property to east of business park in reach. Includes wetlands and groundwater recharge areas. Site is 98 acres.
NC-7	North Creek Forest Protection 2	WRIA 8 Chinook Salmon Conservation Plan/N371	No	Protect Boy Scouts Property: Protect forested, steep sloped property to west of business park in reach. Includes wetlands and groundwater recharge areas. Potential development proposal for site. Property is 31.35 acres.
Reach 6				
NC-1	In-Plant Conifers at Cascadia Floodplain	WRIA 8 Chinook Salmon Conservation Plan/N365	No	Add Conifers to Cascadia Project: Add additional conifers to the previously done Cascadia restoration project for future LWD recruitment. Beavers may affect what areas conifers can be planted; should be taken into consideration during planting plan. Property is 59 acres and owned by the University of Washington.
NC-2	North Creek Restoration Upstream From Mouth	WRIA 8 Chinook Salmon Conservation Plan/N366	No	Restore Lowest Reach of North Creek: Explore improving North Creek corridor from mouth to start of Cascadia Project. Creek is very constrained in this reach by roads and a new interchange is planned in area. Land is owned by King County and WDOT. Potential WDOT mitigation. Reach is 624 linear feet.
SR-8 (also in Reach 10)	Riparian Wetland Restoration and Reconnection Near Mouth of North Creek	WRIA 8 Chinook Salmon Conservation Plan/N341 Sammamish River Corridor	No	Restore and Reconnect Riparian Wetlands Adjacent to I- 405/SR 522 Interchange at the publicly owned historic wetland area, as described in the Sammamish River Corridor Action Plan. Historically very

Bothell SMP ID #	Project Name	Source/ID #	On WRIA 8, 2010 3-Year Work Plan?	Project Description
		Action Plan, 3-1		large wetland near Cascadia Campus.
Reaches 7 and 8				
SC-1	Swamp Creek Water Quality	City Staff, Ecology's Swamp Creek Fecal Coliform Bacteria Total Maximum Daily Load (TMDL) and other Water Quality Monitoring Program Results.	No	Includes Little Swamp Creek. High fecals noted. Leaky septs are a possible source. See Ecology's TMDL.
SC-2	Locust Creek Park and Trail Restoration	City Staff and Planning Commission	No	The City's Locust Creek Park Master Plan shows wetland and riparian vegetation enhancements, and culvert upgrade, among other park improvements.
Reach 9				
SR-6 (also Reach 15)	Parr Creek Restoration and Enhancement (Tributary 0070A)	City Staff	No	Study the potential to increase connectivity of wetlands to the Sammamish River. Study channel modifications to Parr Creek such that it has less of trapezoidal shape and more meandering with diverse riparian corridor. One objective is to reduce required landscape maintenance of the current channel configuration.
SR-7	Norway Hills Groundwater Assessment and Sammamish river Pool Formation	WRIA 8 Chinook Salmon Conservation Plan/N340 Sammamish River Corridor Action Plan, Programmatic Recommendations, P2 – See also project SR-11, below.	No	Evaluate creation of pools in the Norway Hill area of the Sammamish River where some groundwater sources are piped to the river as part of the stormwater system. Determine if groundwater inflows at Norway Hill are in need of special protection or mitigation.
Reaches 9-14				
SR-9	Regrade Banks to Create Flood Benches	WRIA 8 Chinook Salmon Conservation Plan/N343	No	Regrade Banks, Create Shallow Rearing Habitat, and Restore Riparian Vegetation: Regrade banks, create flood benches below high-water

Bothell SMP ID #	Project Name	Source/ID #	On WRIA 8, 2010 3-Year Work Plan?	Project Description
				mark, and plant banks and benches with native vegetation, especially downstream of the major tributaries. An "emerging" bench/ wetland would provide juvenile salmonid shallow rearing habitat.
SR-10	Basin-wide Riparian Restoration	Sammamish River Corridor Action Plan, Programmatic Recommendations, P1 and P3	No	Restore riparian areas (biological, P1) and buffers (regulatory, P3) throughout the entire Sammamish River Corridor, tributaries, wetlands.
SR-11	Pool creation and enhancement	Sammamish River Corridor Action Plan, Programmatic Recommendations, P2	No	Create and enhance pools in the River Channel. 7 possible such locations shown in the City on Figure 7 of the Action Plan
SR-12	Water withdrawal reduction	Sammamish River Corridor Action Plan, Programmatic Recommendations, P7	No	Reduce unauthorized water withdrawals.
Reach 10				
SR-5	Tributary 0069 Restoration and Enhancement	WRIA 8 Chinook Salmon Conservation Plan/N339 Sammamish River Corridor Action Plan, 2-4	Yes	Possible Restoration Opportunities at Tributary 0069, and Sammamish River Confluence: correction of fish passage barriers, riparian restoration, placement of large woody debris, and creation of cool-water refuge pools.
SR-8 (also Reach 6)	Riparian Wetland Restoration and Reconnection Near Mouth of North Creek	WRIA 8 Chinook Salmon Conservation Plan/N341 Sammamish River Corridor Action Plan, 3-1	No	Restore and Reconnect Riparian Wetlands Adjacent to I- 405/SR 522 Interchange at the publicly owned historic wetland area, as described in the Sammamish River Corridor Action Plan. Historically very large wetland near Cascadia Campus.
Reach 11				
SR-2	Wetland enhancement and remnant side channel reconnection – LB Sammamish	WRIA 8 Chinook Salmon Conservation Plan/N338 Sammamish River Corridor	Yes	Enhance and Reconnect Riparian Wetlands and remnant side channels adjacent to 102nd Avenue bridge on left bank.

Bothell SMP ID #	Project Name	Source/ID #	On WRIA 8, 2010 3-Year Work Plan?	Project Description
	River at 102nd Avenue	Action Plan, 2-3		
SR-3	Tributary 0068 Restoration and Enhancement	WRIA 8 Chinook Salmon Conservation Plan/N339 Sammamish River Corridor Action Plan, 2-1	Yes	Possible Restoration Opportunities at Tributary 0068, and Sammamish River Confluence: correction of fish passage barriers, riparian restoration, placement of large woody debris, and creation of cool-water refuge pools.
Reach 12				
SR-1	Wetland restoration and reconnection to Sammamish River - RB downstream of 102nd Avenue	WRIA 8 Chinook Salmon Conservation Plan/N337 Sammamish River Corridor Action Plan, 2-2	Yes	Wetland Restoration on Right Bank in Bothell: Restore historic wetlands on right bank downstream of 102 nd Avenue bridge to be seasonally inundated wetlands with small channels connecting them to the river.
SR-4	Horse Creek Restoration and Enhancement (Tributary 0057A)	WRIA 8 Chinook Salmon Conservation Plan/N339 Sammamish River Corridor Action Plan, 2-4	Yes	Possible Restoration Opportunities at Tributary 0057A, (Horse Creek) and Sammamish River Confluence: correction of fish passage barriers, riparian restoration, placement of large woody debris, and creation of cool-water refuge pools. The outfall culvert to the river may be undersized. .

Additional restoration opportunities will be expanded upon during development of the Shoreline Restoration Plan (see Section 7.2, Restoration Plan), including flooding, habitat and water quality projects that are identified by Snohomish County in its drainage needs reports (SCSWM 2002a and 2002b).

5 Land Use Analysis and Implications

5.1 Introduction

Land use patterns are an important consideration in SMP analysis because such analysis can identify opportunities for “preferred uses,” especially water-dependent, water-related and water-enjoyment uses. Land uses adjacent to the water are also a determinant in assigning environment designations to specific sections of the shoreline. Additionally, an analysis of land use conditions is

necessary to determine potential land use changes and their effect on shorelines with respect to SMA objectives. Finally, the existing land uses and proposed environment designation boundaries and provisions must be mutually consistent with the City's comprehensive plan.

5.2 Land Use Analysis

The character of the North Creek shoreline is mixed, with reaches of residential areas interspersed with reaches of an office/commercial/industrial pattern. Reach 6 (North Creek – Campus Reach) is characterized by the open space portions of the CCC/UW-B campus. The future land use designations and zoning reflect these same patterns. Along the entire waterbody, there is scattered vacant land with some potential for additional housing and employment. Redevelopment may occur in limited areas according to Snohomish County and King County Buildable Lands analyses (Snohomish County 2007; King County 2007), and the Bothell Comprehensive Plan and Zoning allow for taller, more intense development than presently exists in mixed use, commercial, and industrial areas. However, the land use pattern is not expected to significantly change.

The Swamp Creek land use pattern is predominantly residential with some public and private parks, recreation and open space. Future land use designations and zoning also match this pattern. There is some vacant or redevelopable land that may have residential capacity, largely in the Bothell reaches of the creek, based on Snohomish County Buildable Lands analysis (Snohomish County 2007).

The Sammamish River land use pattern is mostly flanked by public and private parks, recreation and open space with occasional residential and commercial uses. Again, future land use designations and zoning do reflect that pattern. Based on King County Buildable Lands analysis there is some potential for development on some vacant properties, but it is limited given much of the abutting property is in public ownership (King County 2007).

A reach by reach review of land use is provided in Tables 2 and 18.

Table 18. Likely changes in land use and implications for shoreline management.

Assessment Unit	Likely Changes in Land Use
1. North Creek – Thrasher's Corner (north of SR-524)	Existing land uses consist primarily of mobile homes accompanied by a mix of single-family residential, office, industrial, and multifamily residential. There is minimal vacant land along the potentially associated wetland. On the whole, given the similarity between planned and existing land uses, no significant changes are anticipated.
2. North Creek – Centennial Park	Currently, most of the land within this reach is classified as park or vacant including Centennial Park, though the presence of wetlands and streams and required buffers would limit future development. The two largest

Assessment Unit	Likely Changes in Land Use
	comprehensive plan land use designations are medium density residential (Centennial Park) and Residential Activity Center, Office Professional, Light Industrial. Future development in this reach is therefore likely to consist of City park, professional offices and/or residential uses.
3. North Creek – Canyon Park	While the majority of this reach is developed with office, warehouse, and industrial uses, and very little vacant land is available for development, current comprehensive land use designations would allow more intense (taller) development.
4. North Creek – Fitzgerald Reach (228th Street SE to 240th Street SE)	Current land uses consist primarily of single-family residences and a large amount of vacant or underutilized land. Vacant or underutilized land comprises 49% of the reach area, making the potential for future development very high. Based on the low density (one unit per acre) land use designations currently in place, future development in the reach is likely to be of a very similar type as the existing residential pattern.
5. North Creek – North Creek Business Parks (240th Street SE to I - 405)	Current land uses in the area are a mix of commercial, office, parks/recreation, residential, warehouse/industrial, and open space tracts. Private open space comprises approximately 35% of the reach area. The Bothell Comprehensive Plan designates the entirety of this reach as Residential Activity Center/Office-Professional/Community Business/Light Industrial.
6. North Creek – Campus Reach (I - 405 to Sammamish River)	The entirety of this reach is located on the CCC/UW-B campus and consists of a large wetland conservation area. The Bothell Comprehensive Plan designates the area as Campus, and no changes to land use are likely to occur.
7. Swamp Creek – City of Bothell ('a' north of 228 th Street SW and 'b' south of 228 th Street SW)	This reach lies outside the current Bothell planning area and is designated for Urban Low Density Residential use (4-6 du/ac) by Snohomish County. Current land uses in this area consist primarily of single-family residences and parks and open space. Vacant land comprises approximately 15% of the reach area, and this land is likely to convert to residential use, similar to the rest of the reach. The City of Bothell conducted public hearings to assign pre-annexation planning and zoning for this area which generally maintains the existing residential development pattern.
8. Swamp Creek – City of Brier Reach	This reach consists of approximately 5 acres in the City of Brier and unincorporated Snohomish County. Snohomish County has designated its portion of the reach as Urban Low Density Residential (4-6 du/ac). The City of Brier has designated its portion of the reach for low-density, large-lot residential development. Current land uses consist of single-family residences and vacant land. Due to the nearly exclusively residential nature of Brier, any future development is anticipated to be similar to the existing residential pattern.
9. Sammamish River – Woodinville Drive (from east city limits to mobile home park)	Current land uses in the area consist primarily of parks and open space, with a mix of commercial, office, transportation facilities, and vacant land. The City of Bothell Comprehensive Plan designates roughly half of this reach as Park, with the remainder designated for Office-Professional, Community Business, Light Industrial, General Commercial,

Assessment Unit	Likely Changes in Land Use
	Mobile Home Park, or Residential (1 du/4,000 square feet). Due to the presence of a large right-of-way for the adjacent I-405/SR-522 interchange, as well as the small amount of vacant land, land uses in this reach are not anticipated to change significantly.
10. Sammamish River – Brackett's Landing (from Valley View mobile home park to Sammamish River Trail bridge crossing)	The Bothell Comprehensive Plan designates this reach primarily for residential development at a variety of densities, and current land uses consist of single-family homes, multifamily residences, and mobile homes. A small amount of land is currently vacant (less than 3 acres); therefore no significant changes in land use are anticipated.
11. Sammamish River - Sammamish River Park	<p>This reach on the south bank of the Sammamish River is primarily designated for Public Parks and Open Space. This designation accounts for approximately 70% of the reach area, with the remainder designated for medium-density residential uses. Current land use in the area consists primarily of vacant land (which is City parkland), followed by parks and recreation uses (trails) and single-family residences.</p> <p>While vacant land comprises more than half of the land in the reach area, the widespread designation of this land as Public Park and Open Space and the presence of extensive wetland and floodplain areas is likely to limit development in the area. What future development does occur is likely to be similar to the existing development pattern.</p>
12. Sammamish River - Downtown (from Sammamish River Trail (SRT) bridge to Park at Bothell Landing bridge)	This reach on the north bank of the Sammamish River is designated primarily as SR-522 Corridor, Mobile Home Park, or Public Park and Open Space by the Bothell Comprehensive Plan. A very small area of Downtown Neighborhood (less than 2 acres) also falls within the reach boundaries. Current land uses consist mostly of mobile homes, offices, light manufacturing, and vacant land. Since redevelopable properties are concentrated along the SR-522 corridor, future development is likely to increase the amount of highway-oriented commercial development.
13. Sammamish River – Bothell Way Corridor (from Bothell Landing Bridge to 96th Avenue NE)	The Bothell Comprehensive Plan designates approximately half of this reach as Public Park and Open Space, with the remainder divided between SR-522 Corridor and Residential (1 du/4,000 square feet) designations. Approximately half the land in this reach is currently vacant, and multifamily residential accounts for most of the remaining area. The reach includes a portion of the Park at Bothell Landing, as well some commercial and office uses (less than one acre, combined). Due to topography, much of the vacant land along the river is likely to remain vacant, though several properties south of NE 180 th Street on SR-522 could potentially redevelop, increasing the amount of commercial development within this reach.
14. Sammamish River – Wayne Golf Course	The Bothell Comprehensive Plan designates this reach as exclusively residential. However, the reach is occupied mostly by the Wayne Golf Course; the City has purchased the development rights on the "front nine" using King County open space bonds. A few acres of single- and multi-family residences, transportation/utility facilities, and vacant land

Assessment Unit	Likely Changes in Land Use
	are also currently located within this reach. Due to the presence of the golf course and lack of vacant land, land uses in this area are not anticipated to change significantly.
15. Sammamish River – Bothell Business Park Floodway	The Bothell Comprehensive Plan designates this reach as a mixture of Residential Activity Center, Office-Professional, Community Business, Light Industrial, and Motor Vehicle Sales Overlay. Current land uses consist of commercial and industrial development, with a very small amount of park land and open space. Given the negligible amount of vacant property in the area, land uses are not likely to change dramatically. Future development is likely to be similar to the current urbanized pattern.

5.3 Shoreline Designations

As part of SMP development, the shoreline is to be classified into specific shoreline environment designations based upon existing land use patterns, baseline inventory and analysis results, goals stipulated in the Cities' Comprehensive Plans, and Ecology criteria. Ecology Guidelines include six recommendations for shoreline environment designations (listed below) . These are compared in Table 19 to existing City or County designations that currently apply to the shorelines (see Figures 1a and 1b, Pages C-1/2). However, each jurisdiction may use alternate or parallel environment designations, as appropriate, as long as they provide equal or better protection than the standard.

- Natural: "shoreline is ecologically intact ... currently performing an important, irreplaceable function or ecosystem-wide process that would be damaged by human activity;" "considered to represent ecosystems and geologic types that are of particular scientific and educational interest;" "unable to support new development or uses without significant adverse impacts to ecological functions or risk to human safety."
- Urban Conservancy: "suitable for water-related or water-enjoyment uses;" "open space, flood plain or other sensitive areas that should not be more intensively developed;" "potential for ecological restoration;" "retain important ecological functions, even though partially developed;" "have the potential for development that is compatible with ecological restoration."
- Rural Conservancy: "currently supporting lesser-intensity resource-based uses, such as agriculture, forestry, or recreational uses, or is designated agricultural or forest lands pursuant to RCW 36.70A.170;" "currently accommodating residential uses outside urban growth areas and incorporated cities;" "shoreline is supporting human uses but subject to

environmental limitations, such as properties that include or are adjacent to steep banks, feeder bluffs, or flood plains or other flood-prone areas;" "high recreational value or with unique historic or cultural resources;" "shoreline has low-intensity water-dependent uses."

- High Intensity: "shoreline areas within incorporated municipalities, urban growth areas, and industrial or commercial "rural areas of more intense development," as described by RCW 36.70A.070 if they currently support high-intensity uses related to commerce, transportation or navigation; or are suitable and planned for high-intensity water-oriented uses."
- Shoreline Residential: "shoreline areas inside urban growth areas, as defined in RCW 36.70A.110, incorporated municipalities, "rural areas of more intense development," or "master planned resorts," as described in RCW 36.70A.360, if they are predominantly single-family or multifamily residential development or are planned and platted for residential development."
- Aquatic: "lands waterward of the ordinary high-water mark." (WAC 173-26-211)

While use environments vary in the variety of land uses and level of development they may allow, all use environments will be subject to vegetation conservation standards, critical area regulations, and other requirements that are intended to balance preferred uses and ecological protection and achieve no-net-loss of ecological function.

Table 19. Shoreline Designations – Current City of Bothell Designations and Ecology Recommendations

Ecology Recommendations	Bothell Current Equivalent Designations (see Figures 1a & b, Pages C-1/2)	Snohomish County Current Equivalent Designations
Natural	Natural: Not applied in Bothell's current shoreline jurisdiction. Natural: Not applied in Bothell's current shoreline jurisdiction.	Natural: Not applied in Bothell/Brier MUGAs.
Urban Conservancy	Conservancy: Bothell applies this designation to portions of the Sammamish River. See Figure 1B.	Urban Conservancy: Not applied in Bothell/Brier MUGAs.
Rural Conservancy	Rural: Bothell applies this designation to portions of the Sammamish River. See Figure	Rural Conservancy: Not applied in Bothell/Brier MUGAs.

Ecology Recommendations	Bothell Current Equivalent Designations (see Figures 1a & b, Pages C-1/2)	Snohomish County Current Equivalent Designations
	1B.	
High Intensity	Urban: Bothell applies this on portions of North Creek and Sammamish River. See Figure 1B.	Urban: Snohomish County applies this designation to North Creek and Swamp Creek.
Shoreline Residential	No equivalent.	Shoreline Residential: Snohomish County does not apply this use environment.
Aquatic	No equivalent.	Aquatic: all waterbodies in MUGA.
No equivalent.	No equivalent.	Potential Associated Wetlands: Applied to North Creek in Bothell MUGA.

6 Public Access Analysis and Implications

6.1 Introduction

Public access includes the ability of the general public to reach, touch, and enjoy the water's edge, to travel on the waters of the state, and to view the water and the shoreline from adjacent locations.

WAC 173-26-221(4)(c) states that:

“Local governments should plan for an integrated shoreline area public access system that identifies specific public needs and opportunities to provide public access... This planning should be integrated with other relevant comprehensive plan elements, especially transportation and recreation.”

To support this planning, WAC 173-26-201(3)(c) calls for local governments to inventory existing and potential shoreline public access sites, including public rights-of-way and utility corridors. Because shoreline access includes visual access, important views of the water from shoreline areas were also identified.

Information about public access sites in the Cities was drawn from site visits; aerial photographs; the Cities' Comprehensive Plans; Bothell's Parks, Recreation and Open Space Plan; the Cities' park and recreation staff and/or websites; and the Cities' land use and parks maps.

6.2 Assessment Unit Conditions

Table 20 summarizes available public access opportunities for each assessment unit, including any privately owned open space or trail systems present in the area. The Sammamish River has a continuous network of public parks, open space and trails, with a private golf course on the west. South of 228th Street SE, North Creek shorelines have a fairly continuous corridor of public and private open space and trails. North of 228th Street SE, recreation opportunities are mostly associated with Centennial Park. Swamp Creek is largely developed with residential uses and does not have as much parks and recreation, though private open space is located along some portions of the creek north of 228th Street SW and public parks are located near Locust Way.

Table 20. Acreage of City Open Space and Parks by Assessment Unit within Shoreline Jurisdiction.

Assessment Unit	Open Space (Acres)	Parks (Acres)	Description
1. North Creek – Thrasher’s Corner (north of SR-524)	-	-	Does not currently contain any public or private parks or open space
2. North Creek – Centennial Park	31.5	4.6	Contains a large portion of Centennial Park, which includes developed park land, as well as publicly owned open space. Public access to the shoreline includes trails within the park. The development located on the east side of the reach has a trail and a public access easement.
3. North Creek – Canyon Park	-	-	Does not contain any public parks or open space, but the area does include private open space, as well as extensive trails along both sides of North Creek that connect the riparian areas with Canyon Park
4. North Creek – Fitzgerald (228 th Street SE to 240 th Street SE)	-	-	No public parks are located in this area, but the reach does contain approximately 3.5 acres of private open space, as well as trails connecting residential areas to the creek.
5. North Creek – North Creek Business Parks (240 th Street SE to I - 405)	-	-	No public parks are located in this area, but the reach does contain approximately 23.2 acres of private open space and an extensive network of trails connecting the shoreline with the North Creek sports fields farther south.
6. North Creek – Campus (I - 405 to Sammamish River)	68.3	-	Reach is characterized by a large open space area on the CCC/UW-B campus. Trails provide access to the perimeter of the open space/wetland area, but few trails penetrate the interior in order to preserve its undeveloped state. Visual access is available from the campus and from the adjacent I-405 and SR-522 freeways.
7. Swamp Creek – City of Bothell (“a” north of 228 th Street SE and “b”	-	5.6	This reach includes several acres of park property on Locust Way that provide public access to the west bank of Swamp Creek. Approximately 22

Assessment Unit	Open Space (Acres)	Parks (Acres)	Description
south of 228 th Street)			acres of private open space are also included in the reach area, both in the south (across Swamp Creek from Locust Way Park) and at the northern end of the reach near 14 th Ave West.
8. Swamp Creek – City of Brier	-	-	No public parks are located in this reach. In the Brier City limits, a large property has developed with residential uses but has protected riparian critical areas with 200 feet of the OHWM, and it will largely stay as private open space/critical areas.
9. Sammamish River – Woodinville Drive (from east city limits to mobile home park)	14.0	-	The reach contains public open space along both sides of the river, as well as a segment of the Sammamish River Trail. The Sammamish River Trail is a publicly-owned trail that provides pedestrian and bicycle connectivity to other regional parks and trail systems outside Bothell.
10. Sammamish River – Brackett's Landing (from Valley View mobile home park to Sammamish River Trail bridge crossing)	2.5	0.3	This reach contains a small amount of public open space along the Sammamish River, as well as the Brackett's Landing Park. A segment of the Sammamish River Trail also traverses the area.
11. Sammamish River - Sammamish River Park	33.7	1.5	The reach is characterized by the Sammamish River Park and the Sammamish River Trail along the south bank of the river. The majority of this area is undeveloped open space with public access to the shoreline provided by the Sammamish River Trail.
12. Sammamish River - Downtown (from Sammamish River Trail bridge to Park at Bothell Landing bridge)	0.6	1.7	The reach contains portions of The Park at Bothell Landing, as well as public open space. Pedestrian trails provide access between Downtown Bothell and Bothell Landing and the Sammamish River.
13. Sammamish River – Bothell Way Corridor (from Bothell Landing Bridge to 96th Avenue NE)	5.5	7.4	This reach contains portions of the Park at Bothell Landing, as well as several acres of public open space on the north bank of the Sammamish River. Pedestrian trails provide access between Downtown Bothell and Bothell Landing.
14. Sammamish River – Wayne Golf Course	1.9	-	West of the Park at Bothell Landing, the Sammamish River runs through Wayne Golf Course, which, while privately-owned, is open to the public with payment of fees.
15. Sammamish River – Bothell Business Park Floodway	-	0.6	The reach contains little publicly-owned open space or parks. However, it includes approximately 8 acres of privately-owned open space associated with the business park. A trail is also present, linking the business park to the nearby North Creek sports fields.

6.3 Public Access Needs or Opportunities

6.3.1 City of Bothell

The City of Bothell's Comprehensive Plan lists the acquisition of park land along the Sammamish River as a high priority in order to preserve a visual corridor for citizens. Trails along the Sammamish River, especially those that would provide connections to other regional recreation facilities, such as the Burke Gilman Trail, are also to be considered a high priority. The Parks Element of the Comprehensive Plan places emphasis on connecting the Sammamish River and Blyth Parks, making them central to the entire City's park system:

- PR-P8. Blyth Park shall be used as a focal point for a trail system which would connect the Tolt Pipeline, the Sammamish River Trail, the Burke-Gilman Trail and the Riverside Drive Trail to the surrounding residential area.
- PR-P10. Continue acquisition of land for the public along the Sammamish River parkland corridor to preserve a visual corridor, increase parklands and expand trail linkages and river access.
- PR-A8. Pursue acquisition of any lands needed to complete the Sammamish River parkland corridor, especially when such acquisitions would enable the completion of the trail linkages between the Sammamish River and Blyth Parks.

The Bothell Parks, Recreation, and Open Space Action Plan (2008) includes the following improvements in the shoreline jurisdiction:

- Park at Bothell Landing Expansion Acquisition
- Off-Road Trails & Walking Routes
- Trails & Walking Routes ROW or existing parks
- Centennial Park – Phase II Development Regional/Open Space
- Wayne Golf Course – Back “9” Acquisition Open Space
- Blyth Park Playground Improvements
- Sammamish River Trail Hand Boat Launch

Some projects are identified for funding through 2013 and others would be funded over the long term.

6.3.2 City of Brier

The City of Brier does not own parks in shoreline jurisdiction and does not propose new parks in the shoreline vicinity. However, the City's plans do support parks in general through the following Comprehensive Plan policies:

- Policy PR 1.1: Preserve a wide variety of lands for park, open space, and greenbelt purposes including but not limited to:
 - a. Natural areas and natural features with scenic or recreational value;
 - b. Land that may provide public access to water bodies, natural areas and parks;
 - c. Use boundaries and City boundaries;
 - d. Lands that visually or physically connect natural areas or provide important linkages for recreation and wildlife habitat, and;
 - e. Environmentally sensitive areas, including severe landslide hazard areas, steep slopes, floodways of 100-year floodplains, wetlands, stream corridors, and habitat for established, threatened, endangered or highly sensitive wildlife species.
- Policy PR 4.1: Develop a network of open space corridors, multi-use trails and paths throughout the City. This network should provide links between developments and subdivisions and also provide links to parks, open spaces, and other trails in Brier and in adjacent communities.
- Policy PR 1.5: Seek funding from multiple sources for parks and open space acquisition and development.

7 Shoreline Management Recommendations

The following are recommended actions for translating inventory and characterization findings into the draft SMP policies, regulations, environment designations, and restoration strategies for areas within shoreline jurisdiction.

7.1 Shoreline Master Program

7.1.1 Shoreline Environment Designation Provisions

Findings: Department of Ecology Guidelines includes six recommendations for shoreline environment designations: Natural, Urban Conservancy, Rural

Conservancy, High Intensity, Shoreline Residential, and Aquatic. While each jurisdiction may use alternate or parallel environment designations, these alternate designations should provide equal or better protection than the equivalent Ecology recommendations.

Recommendations:

- Consider the six-category use environment scheme as contained within the SMP Guidelines.
- Pre-assign environment designations. Coordinate with Snohomish County to identify any differences between County environment designations and the City's future designations.

Table 21 provides a combined analysis indicating shoreline reach conditions and potential use environments that may be considered as the SMP is developed.

Table 21. Shoreline Environment Designation Evaluation

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
1. North Creek – Thrasher's Corner (north of SR-524)	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Thrasher's Corner assessment unit, the overall shoreline ecological function is considered MODERATE.	Current Land Uses: mobile homes, single-family residential, office, industrial, and multifamily residential. There is minimal vacant land along the potentially associated wetland. On the whole, given the similarity between planned and existing land uses and the minimal availability of buildable land, no significant changes in land use patterns are anticipated.	None.	Potential Associated Wetland Urban (Snohomish County)	The Urban environment, while giving first priority to water-dependent uses, is intended to absorb higher-density uses. Current development is not water-dependent or water-related, though residences are an allowed use in the Urban environment. Based on the anticipated land use patterns, as well as the MODERATE ecological function of the reach, possible use environments include Urban Conservancy (for the potentially associated wetland) and High Intensity (south of wetland).
2. North Creek – Centennial Park	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Centennial Park assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.	Current Land Uses: Vacant, (open space associated with Centennial Park) parks and recreation, and commercial, with limited single family residential. Future development in this reach is likely to consist of professional offices associated with residential activity centers, consistent	31.5 acres open space 4.5 acres of parks Facilities: Centennial Park, including onsite trails.	Urban	The current Urban shoreline designation allows for park, open space, and residential development. Current commercial development does not consist of water-dependant, water-oriented, or water-enjoyment uses. Based on the anticipated land use patterns, as well as the MODERATE/HIGH ecological function of the reach, possible use environments include Natural, Urban Conservancy, High Intensity, and Shoreline Residential, dependent on

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
		with planned future land use.			current conditions and uses. For example, the park could be considered Natural and/or Urban Conservancy while already developed residential areas could be Shoreline Residential and already developed commercial areas could be High Intensity.
3. North Creek – Canyon Park	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Canyon Park assessment unit, the overall shoreline ecological function is considered MODERATE.	<p>Current Land Uses; Parks/recreation and offices with some multifamily and single-family residential, warehouse/industrial, and vacant land.</p> <p>The majority of this reach is developed, and very little vacant land is available for development. However, current comprehensive land use designations would allow more intense (taller) development (e.g. office, business/light industrial, as well as low and medium density residential).</p>	Does not contain any public parks or open space, but the area does include private open space, as well as extensive trails along both sides of North Creek that connect the riparian areas with Canyon Park	Urban	<p>The current park, open space, and residential development in the area is consistent with the current Urban environment. Current commercial, office, and industrial development does not constitute water-dependent, water-oriented, or water-enjoyment uses. Future redevelopment of the area under existing Comprehensive Plan land use designations could introduce additional similar commercial, office, and industrial development to the area.</p> <p>Based on the anticipated land use patterns, as well as the MODERATE ecological function of the reach, possible use environments include High Intensity for the urban uses and potentially Urban Conservancy for the parks/recreation uses.</p>
4. North Creek – Fitzgerald Reach (228th Street SE to	Accounting for the existing hydrologic, vegetative,	Current Land Uses: Primarily single-family residences and vacant	3.5 acres of private open space, as well	Urban	Based on the anticipated land use patterns, as well as the MODERATE/HIGH ecological

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
240th Street SE)	hyporheic, and habitat conditions within the North Creek – Fitzgerald assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.	<p>or underutilized land.</p> <p>Future Bothell: A mix of low and medium-density residential. The majority of the reach also falls within the City's Low Impact Development and North Creek Fish & Wildlife Critical Habitat Protection Area overlays. Vacant land comprises 49% of the reach area, making the potential for future development very high. Based on the low density land use designations currently in place, future development in the reach is likely to be of a very similar type as the existing residential pattern.</p>	as trails connecting residential areas to and along the creek.		function of the reach, possible use environments include Urban Conservancy and/or Shoreline Residential depending on natural environment and developed conditions.
5. North Creek – North Creek Business Parks (240th Street SE to I - 405)	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – North	Current Land Uses: a mix of commercial, office, parks/ recreation, residential, warehouse/industrial, and vacant.	23.2 acres of private open space and a network of trails connecting the shoreline with the North	Urban	The park, open space, and residential development in the area is consistent with the current Urban environment. Current commercial, industrial, and office development does not constitute a water-dependent, water-oriented, or water-enjoyment use.

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
	Creek Business Parks assessment unit, the overall shoreline ecological function is considered toward the higher end of the MODERATE range.	Future Bothell: Residential Activity Center/Office-Professional/Community Business/Light Industrial. Due to the similarity between current and planned land use patterns, no significant changes to land use are anticipated in this reach.	Creek sports fields farther south and the North Creek Regional Trail to the north.		Based on the anticipated land use patterns, as well as the MODERATE ecological function of the reach, possible use environments include High Intensity and Shoreline Residential depending on the land use and environmental conditions.
6. North Creek – Campus Reach (I - 405 to Sammamish River)	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the North Creek – Campus assessment unit, the overall shoreline ecological function is considered MODERATE/HIGH.	The Bothell Comprehensive Plan designates the area as Campus which matches the current uses by the Cascadia Community College and University of Washington-Bothell.	Trails provide access to the perimeter of the open space/wetland area. Visual access is available from the campus and from the adjacent I-405 and SR-522 freeways.	Urban	The entirety of this reach is located on the CCC/UW-B campus and consists of a large wetland conservation area. No changes to land use are likely to occur. Based on the anticipated land use patterns, as well as the MODERATE/HIGH ecological function of the reach, possible use environments include Natural and/or Urban Conservancy, given the habitat restoration that has occurred.
7. Swamp Creek – City of Bothell ('a' north of 228 th Street SW and 'b' south of 228 th Street SW)	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Swamp Creek – City of Bothell assessment	Vacant land comprises approximately 15% of the reach area, and this land is likely to convert to residential use, similar to current and planned uses in	5.6 acres of parks on Locust Way. Also 22 acres of private open space.	Urban (Snohomish County)	Based on the anticipated land use patterns, as well as the MODERATE ecological function of the reach, possible use environments include Shoreline Residential and Urban Conservancy, depending on where there are residential and parks uses.

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
	unit, the overall shoreline ecological function is considered MODERATE.	the rest of the reach.			
8. Swamp Creek – City of Brier Reach	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Swamp Creek – City of Brier assessment unit, the overall shoreline ecological function is considered MODERATE.	Current and future land uses are predominantly residential. Due to the nearly exclusively residential nature of Brier, any future development is anticipated to be similar to the existing residential pattern. No significant changes to land use are anticipated.	None.	Urban (Snohomish County)	Based on the anticipated land use patterns, as well as the MODERATE ecological function of the reach, possible use environments include Shoreline Residential and/or Urban Conservancy depending on current conditions.
9. Sammamish River – Woodinville Drive (from east city limits to mobile home park)	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River, the overall shoreline ecological function is considered LOW/MODERATE.	Current Land Uses: parks and open space, with a mix of commercial, office, transportation facilities, and vacant land. Future Bothell: Designates roughly half of this reach as Park, with the remainder designated for Office-Professional,	14 acres of public open space and a segment of the Sammamish River Trail.	The current shoreline designation in this reach is split between Conservancy on the north bank of the Sammamish River and Urban on the south bank.	In contrast to the Urban environment, the Conservancy environment is intended to protect habitat and natural resources by limiting human presence to non-intensive and non-destructive uses. The Park designation on the north bank is consistent with the Conservancy environment as a water-enjoyment use. The current commercial and office uses on the south bank are not water-dependent or water-related. Based on the anticipated land use patterns, as well as the

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
		<p>Community Business, Light Industrial, General Commercial, Mobile Home Park, or Residential (1 du/4,000 square feet).</p> <p>Due to the presence of a large right-of-way for the adjacent I-405/SR-522 interchange, as well as the small amount of vacant land, land uses in this reach are not anticipated to change significantly.</p>			LOW/MODERATE ecological function of the reach, possible use environments include Urban Conservancy and High Intensity depending on the land use and environmental conditions.
10. Sammamish River – Brackett's Landing (from Valley View mobile home park to Sammamish River Trail bridge crossing)	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River, the overall shoreline ecological function is considered LOW/MODERATE.	<p>Current Land Uses: Single-family homes, multifamily residences, and mobile homes. A small amount of land is currently vacant (less than 3 acres).</p> <p>Future Bothell: Designated primarily for residential development at a variety of densities.</p> <p>Due to the similarities between current and</p>	2.5 acres of public open space and 0.3 acres of Brackett's Landing Park. A segment of the Sammamish River Trail also traverses the area.	Urban	Based on the anticipated land use patterns, as well as the LOW/MODERATE ecological function of the reach, possible use environments include Shoreline Residential and High Intensity depending on intensity of use (e.g. single family versus multifamily).

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
		planned land uses, as well as the small amount of vacant land (less than 3 acres), no significant changes to land use patterns are anticipated.			
11. Sammamish River - Sammamish River Park	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River, the overall shoreline ecological function is considered MODERATE.	<p>Current Land Use; Vacant land, followed by parks and recreation uses and single-family residences.</p> <p>While vacant land (which is City parkland) comprises more than half of the land in the reach area, the widespread designation of this land as Public Park and Open Space is likely to limit development in the area. Future development is likely to be similar to the existing development pattern.</p>	<p>33.7 acres of open space 1.5 acres of parks</p> <p>Facilities: Sammamish River Park and the Sammamish River Trail</p>	Conservancy	<p>The current park is consistent with the Conservancy environment as a water-oriented use that enhances the shoreline area. Residential development is not currently listed in the Bothell Shoreline Master Program as being compatible with the Conservancy Environment.</p> <p>Based on the anticipated land use patterns, as well as the MODERATE ecological function of the reach, possible use environments include Urban Conservancy and Shoreline Residential to recognize the park and dwellings, respectively.</p>
12. Sammamish River - Downtown (from SRT bridge to Park at Bothell)	Accounting for the existing hydrologic, vegetative, hyporheic, and	Current Land Uses: Mostly mobile homes and vacant land.	0.6 acres of open space 1.7 acres of parks	The current shoreline designation is a mix of Urban	The existing mobile home park and highway corridor development east of 102 nd Ave NE are not water-dependent or water-oriented uses,

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
Landing bridge)	habitat conditions within the Sammamish River, the overall shoreline ecological function is considered LOW/MODERATE.	Since redevelopable properties within this reach are concentrated along the SR-522 corridor, future development is likely to increase the amount of highway-oriented commercial development.	Facilities: The Park at Bothell Landing, and public open space. Pedestrian trails provide access to the Sammamish River between Downtown Bothell and Bothell Landing.	and Conservancy. The Urban environment generally incorporates the north bank of the Sammamish River from the eastern end of the reach to 101 st Ave NE. From this point to the western end of the reach, the designation is Conservancy.	though this intensity of development is appropriate for the Urban environment. The Conservancy portion of the reach is primarily occupied with the Park at Bothell Landing, which is a water-oriented and water-enjoyment use that provides public access to the water and enhances the shoreline environment. Based on the anticipated land use patterns, as well as the LOW/MODERATE ecological function of the reach, possible use environments include Urban Conservancy and High Intensity for the park and non-park uses respectively.
13. Sammamish River – Bothell Way Corridor (from Bothell Landing Bridge to 96th Avenue NE)	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River, the overall shoreline ecological function is considered LOW/MODERATE.	Current Land Uses: Vacant and multi-family residential. Due to topography, much of the vacant land along the river is likely to remain vacant, though several properties south of NE 180 th Street on SR-522 could potentially redevelop, increasing the amount of commercial	5.5 acres of open space 7.4 acres of parks Facilities: Portions of the Park at Bothell Landing, as well as several acres of public open space. Pedestrian trails provide access	The current shoreline designation is mostly Urban with a small area of Conservancy near 96 th Ave NE.	Based on the anticipated land use patterns, as well as the LOW/MODERATE ecological function of the reach, possible use environments include Urban Conservancy and High Intensity for the park and non-park uses respectively. Vacant lands, depending on vegetative conditions, may also be appropriate for Urban Conservancy or Shoreline Residential.

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
		development within this reach.	between Downtown Bothell and Bothell Landing.		
14. Sammamish River – Wayne Golf Course	Accounting for the existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River, the overall shoreline ecological function is considered MODERATE.	<p>Current Land Uses: Wayne Golf Course, single-family residences, transportation/utility facilities, and vacant land. The golf course represents a water-enjoyment use in the shoreline area.</p> <p>Future Bothell: Residential designations. The City has also purchased the development rights on the “front nine” using King County parks bonds.</p> <p>Due to the presence of the golf course in this reach and a lack of vacant land, land uses in this area are not anticipated to change significantly.</p>	<p>1.9 acres of public open space</p> <p>In addition, Wayne Golf Course – private open space development rights including a sight easement along the “front nine”</p>	Rural	Based on the anticipated land use patterns, as well as the MODERATE ecological function of the reach, possible use environments include Urban Conservancy for the conserved portion of the golf course and Shoreline Residential for the “back nine” where development rights remain.
15. Sammamish	Accounting for the	Current Land Uses:	0.6 acres of	Urban	The current development pattern of

Assessment Unit	Ecological Function Summary	Land Use Patterns	Public Access	Current SMP Designation	Implications for Shoreline Management
River – Bothell Business Park Floodway	existing hydrologic, vegetative, hyporheic, and habitat conditions within the Sammamish River – Bothell Business Park Floodway assessment unit, the overall shoreline ecological function is considered LOW.	Commercial and industrial development, with a very small amount of park land and open space. Given the negligible amount of vacant property in the area, land uses are not likely to change dramatically. Future development is likely to be similar to the current urbanized pattern.	public park 8 acres of privately-owned open space associated with the business park. A trail is also present, linking the business park to the nearby North Creek sports fields.		commercial, office and industrial uses does not represent water-dependent or water-oriented uses. Based on the anticipated land use patterns, as well as the LOW ecological function of the reach, possible use environments include High Intensity and Urban Conservancy depending on environmental and land use conditions.

7.1.2 General Policies and Regulations

Critical Areas

Findings: Critical areas influence many shoreline functions both directly and indirectly. For example, riparian zones directly affect the quality of shoreline habitat for fish and wildlife, they improve nutrient uptake and biofiltration, and they increase sediment storage functions. Several shoreline units in North Creek and Swamp Creek have moderate or somewhat degraded functions. These shorelines would benefit from additional protection. All of the Sammamish River units have degraded riparian conditions that call for restoration, in addition to protection of existing conditions. Similarly, the protection of critical areas that are not immediately adjacent to shorelines may buffer the impacts of upland development and improve water quality entering the creeks and river.

Recommendations:

- Consider whether Brier's critical areas regulations should be incorporated into the SMP by reference or through direct inclusion of required elements as an appendix or in the body of the SMP. Direct inclusion of critical areas regulations is recommended to provide maximum flexibility to the Cities in development and modifications of critical areas regulations outside of shoreline jurisdiction. When critical areas regulations are incorporated into an SMP by reference, it provides Ecology with approval authority over future revisions to the critical areas regulations. Bothell's 1998 SMP update chose to include critical areas regulations in the body of the SMP per Ecology's recommendation at that time. Brier's updated critical areas regulations and the critical area regulations incorporated into Bothell's current SMP should be evaluated and modified if needed to meet current Ecology standards for critical areas management in shoreline jurisdiction. SMPs, and their incorporated critical areas regulations, can be amended as frequently as needed, and must be updated no less than every seven years. This will enable the versions of the critical areas regulations applying in and outside of shoreline jurisdiction to be amended simultaneously.
- Of particular note related to Reach 4 (Fitzgerald) of North Creek is the City of Bothell designation of the North Creek Fish and Wildlife Critical Habitat Protection Area (NCFWCHPA). Components of the regulations governing the NCFWCHPA "include special provisions concerning critical areas and buffers, surface water runoff standards, groundwater infiltration protections, implementation of special stormwater design standards, creation of special surface water management practices, cooperation with surrounding jurisdictions and agencies, and other measures as may be appropriate." The City has even identified

acquisition of land in the NCFWCHPA as a potential City action, using fund sources such as grants, general funds, stormwater drainage fees, and other funding sources as they become available (City of Bothell 2004). Appropriate elements of the NCFWCHPA regulations should be carefully integrated into the SMP, either in whole as part of the critical areas regulations appendix or distributed through relevant use and modification regulations pieces in the body of the document. The NCFWCHPA may also be a strong consideration in assignment of environment designations.

Flood Hazard Reduction

Findings: All of the shoreline units in Swamp Creek and the Sammamish River have low to low/moderate flood storage potential. North Creek has a history of flooding that has been managed in several areas through installation and maintenance of structural flood hazard reduction measures. Because of existing development along North Creek and the potential for additional increases in peak stream flows, flood hazard reduction, structural and otherwise, will be an important element in Bothell's updated SMP. .

Recommendations:

- The developed uplands adjacent to North Creek, particularly through the business park areas, are currently protected by recently modified levees from events up to the 100-year flood. However, North Creek may still be vulnerable to flooding if peak flows continue to increase as a result of discharges from upstream developments or other climate factors outside of the City's control. These areas are important to the economic viability of the City of Bothell and these businesses contain materials and processes which, if flooded, would be detrimental to the environment. Accordingly, care needs to be taken to craft regulations that meet minimum WAC requirements laid out in the Guidelines but enable adequate flexibility to accommodate necessary future repair and maintenance to the existing levees. Provisions need to also be included related to maintenance of the Sammamish River flood flow capacity consistent with Corps requirements.

Public Access

Findings: The Sammamish River has a continuous network of public parks, open space, and trails with a private golf course on the west. South of 228th Street SE, North Creek shorelines have a fairly continuous corridor of public and private open space and trails. North of 228th Street SE, recreation opportunities are mostly associated with Centennial Park. Swamp Creek is largely developed with residential uses and does not have as much parks and recreation, though private

open space is located along some portions of the creek north of 228th Street SW, and public parks are located near Locust Way.

Recommendations:

- Recognize Bothell's adopted Parks Recreation Open Space Action Plan (PROSAP) in SMP as a shoreline public access plan for the Sammamish River and North Creek.
- Develop shoreline public access policies and standards for Swamp Creek, though recognize this reach's largely developed residential character.

Vegetation Conservation

Findings: High temperatures throughout many of the shoreline units result from degraded vegetation cover. Conservation of existing shoreline vegetation is an essential component to stabilize water temperatures.

Recommendations:

- Build on the existing protections provided in the Cities' critical areas regulations, including for North Creek the regulations governing the NCFWCHPA.

Water Quality, Stormwater, and Nonpoint Pollution

Findings: Fecal coliform and dissolved oxygen levels are the most common water quality impairments within the Cities' shoreline jurisdiction. Stormwater management and non-point source pollution prevention are key issues to address water quality concerns and avoid further degradation.

Recommendations:

- Include policies and regulations that appropriately incorporate recommendations of the City's and County's water quality-related studies, particularly as related to impaired parameters listed by Ecology.
- Ensure that regulations allow for placement of any water quality-related monitoring devices in shoreline jurisdiction.
- Similar to regulations already in effect in Bothell in the NCFWCHPA (see BMC 12.52.030 and -.040), consider whether special stormwater management provisions may be necessary within other areas of shoreline jurisdiction beyond the standard City requirements contained in the adopted Ecology *Stormwater Management Manual for Western Washington* (found in the City's Surface Water Design Manual). Examples for consideration include: LID requirements, impervious surface limitations,

and forest cover requirements, among others. Because of the other goals of the Shoreline Management Act, these potential requirements would need to be balanced against the need for public access and accommodating water-oriented uses.

7.1.3 Shoreline Modification Provisions

Shoreline Stabilization

Findings: There are some known areas of shoreline stabilization on North Creek and the Sammamish River. Armoring typically occurs along the banks at stream/road crossings and outfalls.

Recommendations:

- Fully implement the intent and principles of the Shoreline Master Program Guidelines, including provisions for ‘soft’ or natural armoring in lieu of ‘hard’ armoring (WAC 173-26-231(3)(a)).

Piers and Docks

Findings: Several small piers occur along the Sammamish River, but none exist in North Creek or Swamp Creek. While all piers will have some impact on the aquatic conditions around and beneath them, including providing habitat for non-native and/or predatory fish species, the size, design, and materials will determine the extent of impact on aquatic habitat.

Recommendations:

- Prohibit piers and docks in North Creek and Swamp Creek.
- Assess dimensional and other standards for new piers and replacement/modified piers contained in the existing SMP and update as needed to provide clarity.
- Consider standards that address materials such as grated decking for dock and pier replacements/modifications that may be proposed in the future along the shoreline.
- Be consistent with Washington Department of Fish and Wildlife and U.S. Army Corps of Engineers design standards, and recognize special local issues or circumstances.

Fill

Findings: Floodplain storage functions are generally moderate to high within the Cities’ shoreline jurisdiction in North Creek, and low in Swamp Creek and the

Sammamish River. Adding fill above or below the OHWM could reduce floodplain and in-stream storage and conveyance functions.

Recommendations:

- Restoration fills should be encouraged, including improvements to shoreline habitats, material to anchor LWD placements, and as needed to implement shoreline restoration.
- Fills waterward of the OHWM to create developable land should be prohibited, and should only be allowed landward of OHWM if not inconsistent with the requirement to protect shoreline ecological functions and ecosystem-wide processes.

Breakwaters, Jetties, Groins and Weirs

Findings: These structures are not found within the Cities' shoreline units. The weir upstream on the Sammamish River in the City of Redmond controls the elevation of Lake Sammamish. In general, engineered in-water structures do not adapt to naturally evolving stream systems and may require removal or revision to avoid future detrimental impacts (e.g., fish passage barriers).

Recommendations:

- Except for purposes of shoreline restoration (or possibly as part of flood hazard reduction), consider prohibiting these modifications.

Dredging and Dredge Material Disposal

Findings: Historically, dredging has occurred along the Sammamish River to maintain its flood carrying capacity. Such dredging has resulted in a uniform channel lacking many beneficial habitat features. Removing sediment by dredging, or adding sediment through the disposal of dredge materials without an explicit beneficial purpose and thorough review of impacts, is likely to result in unintended, adverse consequences onsite or downstream. However, the Sammamish River is a navigable waterbody that is used by the public for boating and recreation. Navigation impediments exist along the Sammamish River which may jeopardize the River's ability to accommodate boat traffic.

Recommendations:

- Except for purposes of shoreline restoration, flood hazard reduction, and maintenance of existing legal moorage and navigation, consider limiting these modifications.

Shoreline Habitat and Natural Systems Enhancement Projects

Findings: Many of the Cities' shoreline units in North Creek presently have moderately well functioning shoreline habitats, shorelines in Swamp Creek have moderate habitat functions, and the Sammamish River shorelines are generally somewhat degraded. The type of recommended enhancement will vary according to the present conditions, but all of the shoreline units would benefit from shoreline habitat enhancement projects.

Recommendations:

- The SMP should include incentives to encourage restoration projects, particularly in areas identified as having lower function. For example, allow modification of impervious surface coverage, density, height, or setback requirements when paired with significant restoration. Emphasize that certain fills, such as streambed gravels or material to anchor logs, can be an important component of some restoration projects.

7.1.4 Shoreline Uses

Agriculture

- This use does not appear relevant to Bothell or Brier SMP updates.

Aquaculture

- This use does not appear relevant to Bothell or Brier SMP updates.

Boating Facilities

Findings: The most significant boating facility in the City is the Blue Heron Marina on the north bank of the Sammamish River, in the Sammamish River – Wayne Golf Course assessment unit (Reach 14). There are private boat launching facilities in other locations.

Recommendations:

- Regulations should be developed for the Blue Heron Marina and other facilities, such as motorized boat, canoe, and kayak launches, that allow for further modifications and upgrades, but are consistent with the WAC requirements contained in the Guidelines.

Commercial Development

Findings: Existing commercial development is common throughout shoreline jurisdiction, but is concentrated along North Creek; there is no significant water-dependent or water-related commercial use apart from the marina on the Sammamish River. The City's comprehensive plan anticipates future commercial development in the shoreline jurisdiction.

Recommendations:

- Recognize commercial uses in Bothell SMP, and consider incentives to attract water-oriented (water dependent, water related, or water enjoyment) commercial uses in appropriate locations along the shoreline.

Forest Practices

Findings: Portions of the SMP jurisdiction are forested, particularly the Centennial Park, Fitzgerald, Swamp Creek, Sammamish River Park, and Bothell Way Corridor reaches.

Recommendations:

- Provide general policies and regulations for forest practices according to the WAC Guidelines.

Industry

Findings: Industrial development in the shoreline jurisdiction is concentrated along North Creek with none considered water-oriented.

Recommendations:

- Recognize industrial uses within shoreline jurisdiction and review regulations to ensure that permitted shoreline industry is water-dependent and/or mixed use.

Mining

Findings: No mining uses are currently within the Bothell or Brier shoreline jurisdiction.

Recommendations:

- Consider prohibiting this use and removing it from this section.

Recreational Development

Findings: Public and private recreation and open space is found along all shoreline waterbodies, particularly the Sammamish River.

Recommendations:

- Allow for passive and active shoreline recreation that emphasizes location along the shorelines in association with City parks, the PROSAP, and the City's Capital Improvement Plan.

Residential Development

Findings: Residential development within shoreline jurisdiction is common along all shoreline waterbodies.

Recommendations:

- Recognize current and planned shoreline residential uses with adequate provision of services and utilities as appropriate to allow for shoreline recreation and ecological protection. Cluster developments may be a means to provide more open space.

Transportation and Parking

Findings: Roadways, bridges, and parking areas are located in some portions of the shoreline, including four major transportation features – I-405, SR-527, SR-524, and SR-522.

Recommendations:

- Allow for maintenance and improvements to existing roads and parking areas and for necessary new roads and parking areas where other locations outside of shoreline jurisdiction are not feasible.

Utilities

Findings: Many shoreline jurisdiction parcels are served by City water and sewer systems, which may require repair or expansion as development in these areas continues.

Recommendations:

- Allow for utility maintenance and extension with criteria for location and vegetation restoration as appropriate.

7.2 Restoration Plan

A Restoration Plan document will be prepared as a later phase of the Shoreline Master Program update process, consistent with WAC 173-26-201(2)(f). The Shoreline Restoration Plan must address the following six subjects (WAC 173-26-201(2)(f)(i-vi)) and incorporated findings from this analysis report:

- (i) Identify degraded areas, impaired ecological functions, and sites with potential for ecological restoration;
- (ii) Establish overall goals and priorities for restoration of degraded areas and impaired ecological functions;

- (iii) Identify existing and ongoing projects and programs that are currently being implemented, or are reasonably assured of being implemented (based on an evaluation of funding likely in the foreseeable future), which are designed to contribute to local restoration goals;
- (iv) Identify additional projects and programs needed to achieve local restoration goals, and implementation strategies including identifying prospective funding sources for those projects and programs;
- (v) Identify timelines and benchmarks for implementing restoration projects and programs and achieving local restoration goals; and
- (vi) Provide for mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans and to appropriately review the effectiveness of the projects and programs in meeting the overall restoration goals.

The Restoration Plan will “include goals, policies and actions for restoration of impaired shoreline ecological functions. These master program provisions should be designed to achieve overall improvements in shoreline ecological functions over time, when compared to the status upon adoption of the master program.” The Restoration Plan will mesh potential projects identified in this report (see Section 4.4 and Table 17) with additional projects, regional or City-wide efforts, and programs of each City, watershed groups, and environmental organizations that contribute or could potentially contribute to improved ecological functions of the shoreline.

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Appendix A

City of Bothell Assessment of Shoreline Jurisdiction

1. **Shoreline Jurisdiction Assessment, December 2009, The Watershed Company**
2. **Assessment of Upper Extent of North Creek Jurisdiction, January 2011, Washington Department of Ecology**

Appendix B

City of Brier Assessment of Shoreline Jurisdiction

Appendix C

City of Bothell Inventory and Analysis Map Folio

Appendix D

City of Brier Inventory and Analysis Map Folio

